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MAY-FLIES OF FALL CREEK.

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The following paper is a preliminary study of the ecology of the May-flies in the streams about Ithaca, N. Y., more especially in Fall Creek. In these, as in most fresh water streams, the nymphs of this order are abundant. In Fall Creek they are the dominant insects of the stream during the months of April, May and June, and by their fine adaptations to diverse environments they offer a satisfying field of study to any brook traveler. The nymphs may be easily secured, but only imagoes exist in most collections, and these usually as dried distorted specimens whose life-histories are little known. The winged or aerial life lasts but a few days at most; the nymphal or aquatic life may extend over two or three years. The imago exhibits great specialization of parts concerned with reproduction and more striking atrophy of other parts than may be seen any where else among insects. Imagoes of all the groups are remarkably alike in superficial appearance. The nymphs, on the other hand, display a series of adaptations as diverse as their environments. Only by rearing specimens from nymphal to adult life may these two stages be linked together. Many of the life-histories of those species found in Eastern North America have been made known. It has been with the hope of adding to the number of these life-histories, as well as with the purpose of gaining more knowledge of the habits of those already known, that this study has been begun. The earlier American workers, Say, Hagen and Walsh* scarcely took up

* Walsh, B. D. On the pupa of the Ephemerinous genus Baetisca Walsh. Proceed. of the Ent. Soc. of Philadelphia. 1864. pp. 200-206.

* Walsh, D. B. List of the Pseudoneuroptera of Illinois. Proceedings of the Natural Sciences of Philadelphia. 1862.

the rearing of nymphs but by their descriptive work they laid the foundation for the life-history studies which have followed. Berry† '03 reared and described the nymphs of Habrophlebia americana Banks, (which nymph is not a Habrophlebia but a typical Leptophlebia), Blasturus cupidus Say, and Callibaetis ferruginea Walsh. A note on the nymphs of the genus Tricorythus was published by Cockerell and Gill '06‡. The largest number of life-histories of Eastern North American forms has been written by Professor James G. Needham in Bulletins 47, 68, and 86 of the New York State Museum, and includes the following species:

Bull. 47.

Heptagenia pulchella Walsh.
Baetis pygmea Hagen.
Siphlurus alternatus Say.
Caenis diminuta Walker.
Hexagenia variabilis Eaton.
Ephemera varia Eaton.

Bull. 124.

Ephemerella dorothea Needham.
Potamanthus diaphanus Needham.

Bull. 86.

Chirotonetes albomanicatus Needham.
Ameletus ludens Needham.
Choroterpes basalis Banks.
Baetis pygmea Hagen.
Callibaetis skokiana Needham.
Ephemerella bispina Needham.
Caenis allecta Needham.
Leptophlebia praepedita Eaton.
Heptagenia interpunctata Say.
Ecdyurus maculipennis Walsh.

By Mr. W. E. Howard.

Polymitarcys albus Say.

With the exception of Callibaetis skokiana, Ephemerella bispina, Ephemerella dorothea, and Potamanthus diaphanus, all of these species have been taken in or near Fall Creek. For some of these further biological data have been secured. In addition to them eight species have been bred which it is believed have not been before recorded. These are all from Fall Creek with the exception of one, Ephemerella cornuta, reared for me by Miss Lucy W. Smith at Salisbury, Connecticut, and here included in the Ephemerella group. The life-histories which are given are those of Iron fragilis, sp. nov., Epeorus humeralis, sp. nov., Ephemerella rotunda, sp. nov., E. tuberculata, sp. nov., E. cornuta, sp. nov., E. deficiens, sp. nov., E. plumosa, sp. nov., and E. spinosa, sp. nov. The description of the female imago has been added to Prof. Needham's life-history of Ameletus ludens, and the Caenis allecta which he placed provisionally in that genus has on rearing been established in Tricorythus.

† Berry, Edward. New or Hitherto Unknown Ephemerid Nymphs of the Eastern U. S. Am. Natural. Vol. XXXVII, pp. 25-31. 1903.

‡ Cockerell, T. D. A., and Marie Gill. Tricorythus, a Genus of May-flies. Univ. of Colo. Studies, Vol. III. No. 3, 1906.

PHYSICAL FEATURES OF FALL CREEK.

The vicinity of Ithaca consists of two highlands between which lies the basin of Cayuga Lake. The west highland known locally as West Hill is a long regular slope, while East Hill upon a terrace of which Cornell University stands, is furrowed with gorges made by streams flowing downward to the lake. On the gradual incline of the Eastern highland these streams flow along as quiet meadow brooks, or broadening out over stony beds are caught in a maze of ripply shallows, but on reaching the steep terraces of the highland they plunge downward through the narrow gorges by a succession of cascades till they come to the plain below. These streams coming far from their source and fed by many tributary waters are flooded and turbulent in the spring, but gradually dwindle to mere brooklets with trickling falls during the mid and late summer, when the tributaries fail of their supply. Few of the main streams become wholly dry. In March and April rich flora and fauna spring from their banks and waters, while through the dry season they supply enough water for the maintenance of life and the reproduction of another generation. Fall Creek, which bounds the Cornell Campus on the north, is a type of these streams.

About one mile east of the campus Fall Creek flows over a broad nearly level bed thickly strewn with flat stones and rocks which project from the water except at periods when the stream is swollen. On one side the creek is bordered by a soft sandy shore, on the other by a shelving ledge. Beyond this point, where the ledge gives place to soft drift, there is a series of permanent pools which mark the entrance of a small tributary spring. A cross section of this upper portion of the stream represents a variety of situations great enough to shelter widely different types of May-fly nymphs. Clinging to the surfaces of the stones in the mid current are the flat nymphs of Epeorus, Iron, Ecdyurus and Heptagenia; clambering in the trash which has collected between the stones are the nymphs of Ephemerella; on the sheltered surfaces or in the quiet border waters are Heptagenias about to transform in company with Leptophlebia, Siphlurus, and Ameletus; hidden in the sandy sweeps are Caenis and Tricorythus and burrowing in the soft muck banks are Hexagenia and Ephemera. Changing from this gradual descent

Fall Creek cuts downward through a narrow gorge, widens into the artificial pond known as Beebe Lake, hurries through a deep gorge and over a series of falls, cascades and riffles to the marsh below. This lower creek is inhabited by those true dwellers of the rapids, Chirotonetes albomanicatus and Baetis pygmea.

To the north of the lower portion of Fall Creek a small streamlet known as Pleasant Brook follows a parallel course to the lowlands. Its pools and cascades shelter a fauna similar to that of Fall Creek if somewhat less rich. This brook possesses the advantage of small size which makes its study easy. Devoid of tributaries to flood it in time of rain, and shut in by shrubbery, this stream furnished a safe place for the rearing cages of nymphs which were captured in Fall Creek.

METHODS OF REARING AND COLLECTING.

Rearing and collecting were begun on April 1, and continued to August, 1, after which only irregular collecting trips were made to the Creek. The only satisfactory method of rearing May-flies is one which keeps them in their own environment or in conditions closely imitating it. For this purpose Prof. Needham used a cylindrical cage made of wire cloth with a cheese-cloth cover. Such cages are the most convenient for carrying in a knapsack and many May-flies have been successfully reared in them. The space within them, however, is small and all surfaces are perpendicular to the water. If the imago becomes entangled, or if it is not strong enough to keep its footing on the upright surface it falls back into the water and drowns, or at least will never be able to transform. When two or three insects are in the same cage, particularly if the cage is in a strong light, there is danger of one or all falling into the water. For these reasons I have designed another cage, which though less conveniently carried about, has the merit of being more roomy and of supplying one slanting surface. This cage may be made of fine copper or galvanized wire cloth. A stiff cloth which will not bend easily will make the best cage. The cages which I used in Fall Creek were about five inches square on the bottom and five inches in height. Such a cage is easily cut and folded from a single piece of wire cloth. In the diagram shown in Fig. 2, the continuous heavy lines represent the cut edges, the lighter lines the folded edges of the laps, and the

dotted lines the angles of the bottom, back, sides, front and cover. The laps on the sides should be folded over the cut edges of the bottom and the front and then securely fastened with solder. The cover may then be pushed down and secured by a wire catch or by a rubber band placed about the cage. When in use a stone should be placed in the bottom of the cage. This will serve the double purpose of keeping the cage upright and of providing a foot hold for the nymphs enclosed within it. In Fig. 1 the completed cage is shown inserted in the water. A represents the stone placed in the cage.

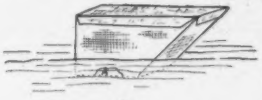


Fig. 1.

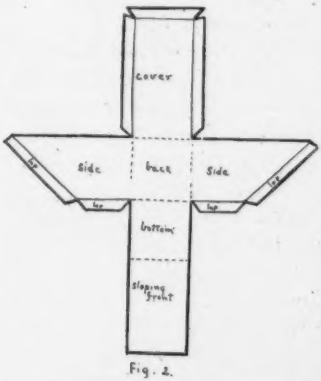


Fig. 2.

Fig. 1. Cage for rearing May flies, showing position in the water.
Fig. 2. Diagram to show construction of cage.

It is best not to insert the cage much more than two inches in the water except where a lowering in the stream is expected. Nymphs confined in this cage will naturally crawl up the sloping side for emergence and the sub-imagoes will find an easy grade on which to walk up to the light. The sub-imagoes will sit on the under side of the cover, but if it be lifted with some care the insects may be safely transferred from the cage to the collecting box.

Many times nymphs are collected for rearing in places not often visited. Such nymphs may be transported alive in jars of their native water with plants or stones to furnish forage and foot-hold. Fragile forms like Epeorus and Heptagenia may be better carried in a can of cotton or sphagnum thoroughly saturated with water. The nymphs should be carefully placed on the surface with a thin, very wet layer above them. If carried in this way they will arrive at their destination in much more perfect condition than if jostled about in a can of water. If a running water aquarium, or better, a convenient small stream is not available, the nymphs brought home for rearing may be placed in flower-pot saucers in which rapid evaporation will keep the water sweet. Small stones projecting from the water should be provided for emerging places. A cylinder of wire cloth with cheese-cloth top may be slipped over the dish so that the sub-imago may be easily caught.

In large aquaria where several kinds of insects are kept, care should be taken to exclude carnivorous beetles, and dragon-fly and damsel-fly nymphs for which May-flies are choice food. May-fly nymphs are mostly herbivorous and need only a supply of diatom-covered stones for forage and some aquatic plants like Chara or Nitella upon which they may depend for foot-hold and hiding. Needless to say the temperature of such an aquarium should be kept as nearly as possible to that of the streams. Of the nymphs which I have endeavored to keep in the aquarium of Cornell University, Blasturus cupidus, Callibaetis fluctuans, and Siphlurus alternatus proved most hardy. These lived from one to four weeks in rather adverse conditions, the water in the aquarium having been treated with aluminum sulphate for drinking purposes.

ECOLOGY AND DESCRIPTIONS.

The May-flies found during the past summer in or very near the Creek will be grouped under the three family heads given by Prof. Needham in Bull. 86. Notes and description of new species are given under their respective headings.

EPHEMERINAE.

Polymitarcys albus Say.

Two sub-imagoes were captured near night-fall on June 20.

Potamanthus sp.

Only two partly grown nymphs of this form were found. Both were taken on June 29 in sandy mud washed by a gentle current.

Hexagenia variabilis Eaton.

Full grown nymphs of Hexagenia variabilis Eaton the largest of our burrowing May-flies, were found abundantly on the sunny afternoon of May 16 in company with Ephemerella and the large dragon-fly Cordulegaster. At the place where they were Fall Creek is a leisurely brook meandering through sparse woodland and open meadow, and hemmed in by soft muck banks. In one such area the sloping banks were mined by Hexagenia nymphs, the open burrows showing only two or three inches apart. Most of the burrows were apparent by their round openings, but from some hairy caudal setae protruded at full length. When a nymph was pulled out it speedily began to burrow again, placing the forelegs together with the blade-like tarsi held vertically. It next pressed them forward and outward at the same time wedging the head between them in the cavity thus made. This movement was followed by a sudden lurch of the body forward accompanied by wriggling of the abdomen. During these motions the second pair of legs was folded close up to the body, while the third pair was held outstretched ready to brace against the mud. These motions rapidly repeated enabled the nymph to bury itself in a surprisingly short time. Some of the soft ooze taken from where the burrows were most numerous was later examined in the laboratory and found to be packed with diatoms. Stomachs of two of the nymphs were found full of silt and diatoms showing that the nymphs had found plentiful forage as they burrowed. Between two and five o'clock of this afternoon about twenty-five subimagoes emerged within a few yards distance. They flew up slowly and usually settled on low shrubs. Many were captured on near-by alders two to five feet from the ground where the yellow markings on their bodies and wings made them conspicuous.

Ephemera simulans Walker.

No representatives of this genus were collected previous to June 14 when a female specimen was captured at large near upper Fall Creek. From June 23 to 30 full grown nymphs were found about two inches below the surface in a muddy basin connected with the main stream. Near this place a swarm of Ephemera consisting of three to four hundred individuals was dancing about fourteen feet in air at half past seven o'clock in the evening of June 29th. Their steady rising and falling continued over the same area as long as the light kept them visible. One female captured from the swarm was placed on the surface of water in the laboratory. She was unable to fly and lay prone upon the surface. Immediately the last four segments of the abdomen began to move spasmodically and eggs poured forth from the oviducts. At the end of one minute the abdomen was empty, and the glass spread with a single layer of white, firmly adherent eggs, easily distinguished with the naked eye.

No Ephemera nymphs were found in the lower Creek up to this time, that cleaner portion being nearly devoid of mud. On the first of July, however, the water in Beebe Lake was allowed to run off, bringing into the Lower Creek large quantities of mud. Three days later the shores below the dam were again examined. Tracks similar to those made by earth-worms covered the bottom near the shore-line. Nymphs were crawling over the surface and setae could be seen projecting from many burrows. From an area of about ten square feet thirty nymphs were removed.

HEPTAGENINAE.

Represented entirely by dwellers in rapid water, this family is the dominant one in number, and the most homogeneous in nymphal form. It is represented here by four of its six North American genera Heptagenia, Epeorus, Ecdyurus, and Iron, given in order of their relative abundance. As a family the Heptageninae has taken possession of the rapid, thoroughly oxygenated water and the alga-covered stones of the middle stream, apparently coming into the calmer waters only at transformation time. In order to secure and keep this position against the mechanical force of the water acting upon them

all alike, they have been forced into a series of similar adaptations. The principle feature of these adaptations are: a generally depressed body; dorsally placed eyes and flaring margins to the head; spreading legs with flattened femora and lateral pectinations on the claws; a series of over-lapping gill lamellae, and flat widely diverging caudal setae.

Heptagenia interpunctata Say.

Five species of the genus Heptagenia were collected and reared during the summer, but only the very common H. interpunctata will be listed until further work can be done upon them. H. interpunctata was common from April 30, when I found nearly grown nymphs beneath the flat stones in a tributary of the creek up to August 1, after which little collecting was done. During this time many emergings were observed, the greater number occurring between two and five o'clock in the afternoon.

Ecdyurus maculipennis Walsh.

Associated with Heptagenia and Epeorus, but with a preference for more gently flowing water, Ecdyurus maculipennis is a frequent dweller in the quieter border water of swift currents. My first collections are dated June 3. From this date till July 25 it was a common associate of Heptagenia and Epeorus,slightly smaller and a swifter runner than either of them. It also bears transportation and change of water with greater hardiness.

Iron fragilis.

The nymph of this species was described by Prof. Needham in 1905. In addition to this description there have been but two records of this genus in North America, Iron nitidus,* Oreg. Cal. and I. longimanus,† Colorado. The first nymphs of this species collected during the summer were found on May 9, in Coy Glen, the stream from which Prof. Needham's specimens were taken. Here thick growths of Cladophora and diatoms support an abundant May-fly population. The nymphs live in the swiftest water, on the under side of the stones, in the falls, or on the smooth rock floor. A census of the inhab-

* Iron nitidus Eaton. Rev. Monog. 246, 1885. Oreg. Cal. Banks, Cat. Neur. Insects. Am. Ent. Soc. '07.

† I. longimanus, Eaton, Ent. Mo. Mag. XVIII, 26, 1881. Rev. Monog. 245, 1885.

itants of twenty stones measuring about seven by eleven inches revealed the following inhabitants listed in the order of abundance, Simulium, Blepharocera, May-flies (Epeorus, Iron. Baetis), Stone-flies and Parnidae. In competition with such structures as the sucking disks of Blepharocera and the limpet like form of the water-penny (Parnidae), Iron has developed a successful hold fast of its own. The first pair of gill lamellae are very large and scoop shaped with their hinder edges overlapping the succeeding lamellae, and their front edges meeting beneath the posterior portion of the thorax. The lamellae diminish in width posteriorly and the last pair are incurved beneath the abdomen. The edges of the lamellae have a thickened border and when closely pressed to the supporting surface a successful holdfast is formed. This is one of three closely allied genera, Epeorus, Iron, and Rhithrogena, which represent remarkable modifications for life in rushing water. All three possess closely overlapping gill lamellae and but two caudal setae. The main differences are in the shape of the ventral abdominal disk which in Epeorus is incomplete, the first and last pairs of lamellae being distant; in Iron nearly complete, the first and last pairs of lamellae nearly meeting; in Rhithrogena the disk is completed by the perfect apposition of these lamellae.

The mouth-parts (Pl. X, fig. 1) are completely hidden from above by the flaring margin of the head with its bordering fringe of soft hairs. Viewed from beneath the small labrum (Pl. X, fig. lr) may be seen curving downward and backward over the tips of the mandibles and maxillae (md. a. and mx. a) to meet the median flaps of the broad labium (l. l. e.) The labium is flat and its outer surface (l) fits close down to the surface upon which the insect is foraging. Along the anterior margin of the outer surface of the labial palp is a series of incurving hairs (l. l. a.), behind these a set of overlapping plates, and still farther backward a single strongly chitinized scraper, (l. c.) On the inner surface of the palp is a semi-circular patch of inwardly directed hairs (l. b.) Closely apposed to the inner surface of the labium is the outer surface of the hypopharynx (fig. 1 hy), made up of two lateral, and one median portion, distinct, except at their bases. The separation of the two lateral portions from the median portion leaves a gutter-like trough between them on the inner side. The labial palpi are freely movable horizontally. They are moved outward, then

pressed slightly downward and inward when feeding. Sometimes the labial palp is slipped between the median (fig. 1, l. e.) and the lateral flaps (fig. 1, l. d.), sometimes over the inner sides of both. In the first case the plates on the outer sides of the palp are brushed by the hairs on the inner side of the median flap while the semi-circular patch of hairs (l. b.) on the inner side of the palp is brushed by those on the outer side of the lateral palp. In the second and more frequent case the outer side of the palp is brushed by both flaps and the semi-circular patch of hairs fits into the chitinized gutter on the adjacent surface of the hypopharynx (hy. a.) Directly above the median portion of the hypopharynx are the grinding surfaces of the maxillae (mx. b.) with those of the mandibles (md. b.) directly above them. Food scraped inward by the labial palps is evidently deposited beneath the hypopharynx. From here it is probably sucked up into the mouth cavity through the slits between the median and lateral folds. The maxillary palps act in a manner similar to those of the labium, but because of their position above the hypopharynx, they must be able to place the food directly in the mouth cavity. The inwardly curving hairs on the lateral borders of the labrum help to keep the food in the mouth while it is being chewed up.

The foregoing observations were made by placing a nymph in a shallow dish of water, throwing a strong light upon it and studying it with a binocular microscope. The nymph was uneasy in this unnatural position and kept its mouth parts continually moving. Nymphs may be studied under more natural conditions if they are placed in a glass-bottomed box with a small amount of forage. The box may be placed upon some support which will elevate it above the table. The bottom may then be tilted at any easy angle and the nymphs studied with a hand lens from beneath.

Occurrence, habitat. The dates on which nymphs or imagoes were collected range from May 1 to June 15. These nymphs were all taken in cool, shaded waters and were most abundant during the early part of the season. The data for those reared in cages is as follows:

1 male emerged May 11, a. m., transformed May 13, a. m. Coy Glen.
1 male emerged May 12, a. m., transformed May 14, a. m., Pleasant Brook.
3 females emerged May 30, p. m., transformed June 1, p. m. Pleasant Brook.
1 female, 1 male emerged June 10, a. m., transformed June 12, M. Fall Creek.

Between the hours of two and four of June 15 about twenty emergings were witnessed from one view-point in a narrow swift portion of Coy Glen Brook. The nymphs popped from the surface of the water and flew unsteadily upward in the sunlight for about 20 or 30 feet when they veered into the tree tops or settled on the side of the gorge.

Iron fragilis sp. nov.

Measurements.

	Length of body	Length of setae	Length of Wing
Male imago	7 m. m.	21 m. m.	7 m. m.
Male subimago	6.5 m. m.	14 m. m.	
Female imago	7 m. m.	15 m. m.	
Female subimago	6.05 m. m.	14 m. m.	

Male imago. (Plate X, figs. 2, 3 and 4). (In alcohol). Body extremely delicate and fragile. General hue dull yellowish white, appearing hyaline in segments 2-7 of the abdomen. Eyes, conspicuous, grayish. Head, parchment color with the eyes gray, darker below; antennae, light brown except for white basal segment; ocelli, ringed with conspicuous, broad band of dark brown. Thorax, yellowish shading brownish above, pale below. Pronotum deeply notched behind. The lateral lobes of the pronotum and the median portion of the mesothorax shaded brown. A sub-triangular area of brown on either side of the median posterior elevations of mesothorax and metathorax. Legs, dull yellowish, the femora with a conspicuous dark brown spot at the middle. Tarsi with joinings and claws brown. Forelegs (Pl. X, fig. 3) longer than the body, its tarsal claws identical with those of the other two. Wings, (Pl. X, fig. 2) hyaline, sub-hyaline near the tip in costal and sub-costal regions. Abdomen. Tergites 1-9 with their posterior borders delicately shaded by transverse bands of brown growing more distinct posteriorly. Sternites, pale. Forceps pale, broad at the base and conspicuous (Pl. X, fig. 4). Setae 2, pale slightly brownish at the base.

Male sub-imago. The sub-imago differs most markedly from the imago in the following respects. The forelegs and setae are shorter, the forceps less conspicuous, and the wings are of the usual grayish sub-hyaline appearance. Head with occiput brownish. Bands of ocelli less prominent than in the imago. Thorax, brown, prominent ridges of mesothorax and metathorax shaded with brown, but without definite sub-trangular markings. Pleurae and sternum with ridges shaded brown. Coxae suffused with brown. Abdomen with tergites 1-10 suffused with brown, the transverse band of brown more distinct than in the imago. An irregularly shaped patch of white in the center of each segment near the pleura. The posterior lateral angles of the tergites whitish.

Female imago. Body heavier than that of the male, all over dull yellowish color; legs of nearly equal length; setae 2. Head with eyes

distant and dark grayish, a whitish area of the head showing between them. Thorax, with the pronotum distinctly lined with brown. Subtriangular areas on mesothorax and metathorax present but less distinct than in the male. Abdomen with tergites shaded with brownish, a distinct transverse band of brown near the posterior border. Sternite 7 produced backward in a rounded lobe whose posterior edge touches that of sternite 8. Sternite 9 produced backward in a lobe with a shallow median indentation on its posterior margin.

Female sub-imago. General color much darker than the male imago. Thorax shaded all over with brown. Sternite 7 produced backward only half the length of sternite 8. The prolongation of sternite 9 much less pronounced and its posterior margin barely indented.

Epeorus humeralis.

(Pl. IX, fig. 1, 2, 7.) The genus Epeorus is represented in Fall Creek by this single species. It is closely allied to Iron but differs from it in the greater distance between the lamellae of the first and last pairs of gills. These nymphs are much larger than those of Iron fragilis, but are harder to transport because of the extreme brittleness of the bases of the lamellae.

Occurrence, habitat. Full grown nymphs and imagoes were taken at various dates from May 25 to July 15. This species is very common in the swift waters associated with Heptagenia and Baetis.

Epeorus humeralis sp. nov.

Measurements.

	Length of body	Length of setae	Antennae
Male imago	10 m. m.	20.5 m. m.	
Male subimago	9 "	12.5 "	
Female imago	9.5 "	13 "	
Female subimago	10 "	11.5 "	
Nymph	11 "	11 "	2.5 m. m.

Male imago. (Pl. IX, fig. 2, 7). (Live specimen). General color dull yellowish, becoming sub-hyaline on segments 2-5 of the abdomen. Conspicuous dark brown spots at middle of femora in all winged stages, larger than those in Iron fragilis; the body less fragile than that of the preceding species; the humeral cross vein blackish; the foreleg about three quarters the length of the body. Head, yellowish white; eyes conspicuous olive green, intersected in the lower portion by a brown band, ventral edge margined by a narrow black band border behind, this in turn by a white band of the same proportions; antennae brown, a brown ridge extending from their basal segments to the inner margins of the eyes; carina on middle of front brown; ocelli ringed with olive. Thorax, above yellowish white, translucent; pronotum partially hidden by the eyes, its lateral lobes shaded with dark brown; mesonotum buffy with edges brown and elevations lighter; scutellum fuscous.

Below, pale whitish yellow, mesonotum margined at the apex with a transverse band of brown. Pleurae and coxal areas pale with irregular shadings of dark brown. Legs whitish; coxae with dark brown spot; femora with conspicuous brown spot and a brownish band just before the apex; more distinct on the anterior legs; tarsi with flap and claw similar to that of Iron fragilis (Pl. X, fig. 3) and identical in all three legs. Wings hyaline with the humeral cross vein blackish brown (in all adult stages). Abdomen, pale whitish, translucent on segments 2-5. Tergites with distinct transverse brown pencilings on their posterior borders and a median broken line of brown more distinct on the posterior portions of the tergites. Sternites pale without markings. Forceps pale, (Pl. IX, fig. 2). Setae whitish.

Female sub-imago. General color of the body slightly darker than that of the imago. Abdomen darker, less translucent. Wings grayish, sub-hyaline. Thorax with markings less sharply defined and general color darker than that of the imago. Abdomen with the tergites suffused with brownish.

Female imago. (Live specimen). Forelegs shorter than those of the male. In specimens containing eggs the abdomen is a bright salmon pink, which does not fade readily in alcohol. Head, with eyes similar to those of the male, but smaller and distant being separated by a broad unmarked portion of the occiput. The dark bands of the ocelli are incomplete and a trifle narrower than those of the male. Thorax, with the pronotum exposed showing the prominent median indentation of its posterior margin; an area on either side the median line with a longitudinal blotch of brown. Abdomen with the tergites slightly darker brown than in the male. Sternite 7 prolonged two thirds the length of sternite 8. Sternite 9 slightly shorter and but shallowly notched on its posterior border.

Nymph. (Pl. IX, fig. 1). Body depressed, widest across the mesothorax gradually tapering to the last abdominal segment. Nymph larger and broader than Iron fragilis with its lamellae flaring; the lamellae of the first and last pairs of gills distant from one another and the tracheation of the lamellae conspicuous. Posterior lateral angles of the abdominal segments produced into backwardly directed spines which guard the bases of the lamellae (Pl. IX, fig. 1). Color, olive-greenish blotched and shaded with brown, pale below. Head with eyes and ocelli prominent, the latter with dark lunate bands on their inner margins. Antennae slender and bare. Lateral margins of the prothorax rounded anteriorly, and flaring. Legs flattened with a row of rather long soft hairs on the posterior margins of the femora and tibiae. General shape conical, rounded above, slightly flattened below. Gill lamellae obliquely reclinate with fasciculate filaments on the dorsal side of their bases. Setae 2, about as long as the body.

Baetinae.

This heterogenous group was represented in the summer's collecting by Blasturus cupidus, Leptophlebia praepedita, Leptophlebia mollis, Choroterpes basilis, Callibaetis fluctuans,

Ephemerella excrucians, Caenis hilaris, Siphlurus alternatus, Chirotonetes albomanicatus, Ameletus ludens, Tricorythus allectus, Ephemerella rotunda, sp. nov., E. tuberculata, sp. nov., E. cornuta, sp. nov., E. deficiens, sp. nov., E. plumosa, sp. nov., and E. spinosa, sp. nov. All of these were taken in Fall Creek except the before mentioned E. cornuta. The descriptions of these species of Ephemerella is here given together with that of the female imago which has been added to Prof. Needham's life-history of Ameletus ludens. Tricorythus allectus, which was placed in that genus by Prof. Cockerell has been established there by several rearings.

Blasturus cupidus Say.

From April 20 to May 1 this species was the dominant May-fly of the quiet pools. On April 30 observations were made in a sheltered pool, tributary to Fall Creek. This pool was about fourteen feet long by five feet wide, carpeted with decaying leaves, and bordered on one side by a thick mat of spirogyra. Between 11:30 and 12:30 o'clock in the bright sunlight, about forty nymphs emerged and the sub-imagoes were captured. A few records of individual emergings were taken of which the following is typical. A nymph appeared from beneath some leaves, came close to the surface of the water and swam about there till a stick was found which projected out of it. It immediately clambered up the stick, thrust its head out into the air and rested there with its gills motionless, but apparently swallowed large gulps of air. Very soon a median split appeared in the mesothorax, widened toward the prothorax and then to the metathorax. The head and eyes of the sub-imago appeared, the mesothorax, then the metathorax, and finally by a sustained pull, terminating in a jerk, the wings were extricated from the wing pads and erected. Apparently exhausted by this effort the insect then paused with the posterior portion of the abdomen and the setae still lying loosely in the cast skin. By another jerk the body was wholly freed from the skin. The insect rested an instant upon the water's surface with its setae held widely divergent and upward, in their natural alert position. Immediately after this it fluttered upward and settled on a low shrub. The entire time from the appearance of the nymph to the completion of its emerging was ten minutes. Of this period, one minute was occupied in swimming, one in taking in air, and three minutes occurred between the appearance of

the median slit in the nymphal skin and the complete freeing of the sub-imago. After its first short flight the insect remained on the shrub for about five minutes before disappearing higher up in the air. This custom of resting upon near-by objects is a habit varying with the species and apparently also with weather conditions. For example, sub-imagoes of Chirotonetes albomanicatus which usually fly upward immediately on emerging in clear weather walk about for a while on the shore, or take very short first flights on dark days. The period of greatest effort during emergence is that which precedes the splitting of the nymphal skin. The splitting is doubtless urged on by the distention of the alimentary canal which is caused by the air or water which has been swallowed.

Mating flights of Blasturus cupidus were observed over Fall Creek in the late afternoon of April 31, the height of their transformation season. About thirty individuals flying in close ranks rose and fell at varying altitudes of ten to thirty feet. When at their greatest height they were scarcely distinguishable against the sky, but when they were lowest the forelegs and the setae might be discerned. The forelegs were held stiffly, straight forward from the head, and the setae, projected at a wide angle behind, appearing to vibrate as the insects swung downward. After a few moments of ecstatic rising and falling, one of the individuals flying high in the swarm descended to one of the lowest, coupled with it and veered obliquely downward and across the stream. When about to alight on the opposite shore the two separated, one disappeared and the other turned back and flew close to the surface of the stream frequently brushing the water with the abdomen. Such matings were three times observed. Attempts to capture a fertilized female failed. The eggs brushed from the abdomen into the rapidly running water were, of course, impossible to find.

Leptophlebia.

Occurrence, habitat. Nymphs of this genus were found in a greater variety of situations than any other group. While it is for the most part a genus which belongs to the small rills it also takes advantage of the secluded places in the larger streams. Two species were common in this locality. These were Leptophlebia mollis, common after May 20, and L. praepedita, collected frequently after May 29.

Leptophlebia praepedita Etn.

This species has already been noted by Prof. Needham (Bull. 86, N. Y., State Mus.) This species is diurnal. Companies of them were seen dancing in bright sunlight on the afternoon of May 29, June 3, 20 and 21. A mating flight on May 29 occurred about five o'clock just above a dashing water-fall of Fall Creek. As the swarm rose and fell at alternate heights of ten to fifteen feet their silvery wings and bodies shone in the sunshine like falling snow-flakes. After half an hour of continuous flying and soaring the swarm gradually disappeared. Of the specimens captured all were males. Earlier in the afternoon a similar but smaller swarm was seen flying above a small tributary rill. This swarm did not at any time fly higher than six feet above the water. Practically the whole swarm was captured at one sweep of a large net. Of the captured insects forty were males and one was a female.

Choroterpes basalis Banks.

This species is plentifully represented in the Creek. The nymph is described in Bull. 86 of the N. Y. State Museum. Little attention was given to this species beyond the collection of nymphs which were constantly associated with Heptagenia.

Ephemerella.

This genus is nearly as diversified in habit as Leptophlebia. The nymphs have been found in pipe drains, in the gravel and trash of still pools, beneath leaves in springs, in the border waters of the creek and in its swiftest ripples. Like Leptophlebia they have been found in rather small numbers and widely scattered. My dates for rearings and captures range from the second week in May to the last of July. Better results would have been obtained if attention had been paid to this group earlier in the season for some species were very rarely found by May 10th.

Ephemerella serrata sp. nov.

Occurrence, habitat. The small nymph of this species was found occasionally in restricted areas of the upper Creek where it crawled about on stones, or in the trash, which was washed by running water. It was found in similar situations at Sheffield, Mass. My reared specimens of this species are dated

June 3rd. Collections of the nymphs were made June 12, 14, and July 1. By July the nymphs were becoming scarce. several cast skins were found on the dry stones of the shore, after the last date, but no nymphs were seen.

	Measurements.	
	Length of body	Length of setae
Male	5 m. m.	6 m. m.
Female imago	4.5 m. m.	
Nymph	5 m. m.	1.2 m. m.

Male imago. General color brown, paler on the legs and below. Head, above, eyes very prominent, upper division reddish brown, lower one darker. Front of head light, antennae light brownish; ocelli white, the lateral ones with an inner lunate band of brown, the median one with a complete ring of brown. Thorax, above yellowish shaded with brown; mesonotum with its posterior margin edged with brown. Ridges of the pleurae shaded with brown. Sternae pale with sub-quadrangular areas of brown before the middle legs and a median shield of brown behind them. Legs pale with a transverse band of brown at the distal end of the femora; first tarsus of the foreleg but slightly longer than the second; the third twice as long as the fourth. Wings hyaline, brownish at the base. Abdomen, brownish above, pale below. Setae 3, pale, the joinings of the basal segments ringed with brown.

Female imago. Eyes small and distant showing the light colored occiput between. Body more robust and abdomen slightly darker than that of the male. Foreleg twice as long as that of the male.

Nymph. Small with head and thorax rounded and the setae curving forward over the abdomen. General color a muddy yellow with darker markings on the dorsal side, pale below. This species is easily distinguished from Ephemerella deficiens by its double median row of spines on tergites 4-7 and by its generally lighter color. Head smooth, (Pl. VI, fig. 5); antennae light brownish, first and second basal segments edged with brown. Thorax, prothorax with a tubercle like elevation on either side the median line. Legs (Pl. VII, fig. 2) with the femora rather stout and their hinder margins bordered with a row of stout hairs sparsely distributed. Claws serrate (Pl. VII, fig. 2) with a chitinous ridged plate on the underside of the tarsus (Pl. VII, fig. 2). Abdomen, above, segments 5-6 pale marked with brown pencilings, other segments brown with darker edges. A double row of irregularly triply dentate spines extending over segments 4, 5, 6 and 7. The lateral margins of segments 4-9 spinose with their posterior lateral angles becoming more acuminate posteriorly. Gills present on segments 3-7; Elytroid lamella absent; the superior lamella simple; the inferior fimbriate lamelliform. Abdomen, beneath, pale with a median row of distinct linear brown spots on sternites 1-9. Setae, 3, sparsely beset with coarse hairs; color, pale with a transverse band of brown across the center.

Ephemerella deficiens, sp. nov.

Occurrence, habitat. Of similar habitat and closely associated with Ephemerella serrata in rapid waters, this species is the more common of the two and was collected frequently during the first half of May. It closely resembles E. serrata in shape and size, but the whole body is blackish while the gill lamellae, the legs, and the setae are nearly white.

	Measurements.	
	Length of body	Length of setae
Male imago	5 m. m.	Setae lost
Nymph	5.2 m. m.	2.5 m. m.

Male imago. General color blackish, thorax blackish brown. Head, eyes prominent, upper division reddish brown, lower division blackish brown (living specimen); ocelli white; antennae, carina and rings of ocelli brown. Thorax, above, pronotum brown; the mesothorax and metathorax blackish brown with blackish edges; pleurae brown with edges blackish; sternum brown with a broad transverse band of yellow behind the first pair of legs. Legs nearly white; coxae and an indefinite band at distal end of the femur brown. Wings hyaline shaded with brown at the base. Abdominal segments shaded with brown giving the effect of annular bands dark on the dorsum, paler beneath. Setae 3, pale at the base. (Only the bases of the setae remained when the specimen was taken from the cage). Forceps and penes are figured in Pl. IV, fig. 4.

Nymph (Pl. VI, fig. 4, Pl. VII, fig. 4, Pl. VIII, fig. 4). Color blackish brown, femora brown, gills, tibiae and tarsi whitish. Body broadest at the metathorax, the thorax arched, the abdomen slightly depressed and curving upward at the posterior end. Setae held upright or curved over the abdomen. Head, bluntly wedged shaped; ocelli inconspicuous whitish; antennae pale with a band of brown just above the basal segment. The maxillae with their palpi totally absent (Pl. VIII, fig. 4). Thorax, above blackish brown, the prothorax bordered laterally by a pale longitudinal band with a brown spot at its center; the prothorax and mesothorax with a longitudinal stripe of pale yellowish on either side the median line. Legs (Pl. VII, fig. 4) with the coxae and femora brown, the under side of the latter with a distinct hook shaped area of whitish. Tibia and tarsi pale whitish, the first two pairs of tibiae with a broad middle and a narrow proximal band of brown; the tarsi of all the legs with a middle band of brown and with the claws similar (Pl. VII, fig. 4). Abdomen above dark blackish brown. The posterior lateral angles of segments 9-10 pale whitish; the lateral margins of segments 1-9 spinose serrate with their posterior lateral angles produced into flat spines which become more acuminate posteriorly; segment 10 without spines and with its posterior margin truncated. Gills present on segments 3-7; Elytroid cover absent; gill lamellae whitish shaded with brown at the base, superior lamina entire, the inferior one bifed.

Abdomen, beneath, brown without markings. Setae 3, with a circlet of spines at their joinings. A broad band of brown across the two outer ones.

Ephemerella lata, sp. nov.

Occurrence, habitat. This species was first taken in Sandy River, Me., a stream similar to Fall Creek, where it was very common. Attempts to rear these nymphs were unsuccessful in both Sandy River and Fall Creek therefore a description of the nymph only can be here included. It occurs in the most rapid water of the stream crawling on the stones much like Heptagenia. My dates for its capture in Fall Creek are June 20 and 24. It is apparently a rare species in the stream.

Measurement.—Nymph. Length of body 7.2 m. m. Length of setae 3.5 m. m.

Nymph (Pl. VI, fig. 6; Pl. VII, fig. 1). General color brown with the prothorax and the eighth tergite conspicuously white. The fore femora very stout (Pl. VI, fig. 6) and edged with stout spines. Body arched above. The ventral side of the body and the legs flattened and modified for clinging to smooth surfaces. Head, sub-quadrangular with the broad truncate ledge projecting forward above the rounded heavily fringed frontal border (Pl. VI, fig. 6). Antennae with a conspicuous triangular ledge projecting above their bases. (Mouth-parts are figured on Pl. VIII, fig. 1). Thorax, prothorax two-thirds as long as the thorax, conspicuously whitish but with the posterior portion shaded brownish, the degree varying in different ages and individuals; mesothorax without markings; metathorax concealed from above. Sternum flattened, brown with pale suture lines. Legs (Pl. VII, fig. 1) with the femora pale marked by a pale transverse band; tibiae brown with two pale transverse bands. Abdomen, rounded above, flattened below. Gills on segments 3-8. Elytroid cover absent. Segments 4-9 with their posterior lateral angles produced backward into flat spines; segments 5-8 with their lateral margins spinose serrate; segments 4-7 with a double median row of small tubercles which arise near the posterior border. Sternite 9 produced backward into a median rounded lobe and two lateral flat spines. Setae 3, light brownish ringed at their basal joinings with darker brown.

Ephemerella tuberculata, sp. nov.

Occurrence, habitat. But a single specimen of this species has been taken. This was a nymph captured on June 22 in the gently flowing border water of the upper Creek.

Nymph, measurements. Length of body, 10.5 m. m.; length of setae, 4.5 m. m.

Body stout arched above, flattened below. Color above dark, below pale, with a median double row of distinct brown spots. Fore-femora very wide (Pl. VII, fig. 5). The head (Pl. VI, fig. 2) with two

large erect tubercles on the occiput. Head, sub-quadrangular slightly flattened with the head projecting forward; a triangular ridge with the median ocellus at its apex projecting above the slightly indented fringed frontal margin. (Pl. VI, fig. 2). Left maxilla figured on Pl. VIII, fig. 3. Thorax, more than half the length of the trunk; color dark above, all except the prothorax pale below; prothorax, above slightly arched and flaring at its postero-lateral angles, a tubercle at the middle of the lateral margin and a smaller one on either side the middle of the posterior margin; mesothorax with one median tubercle. Legs, with femora unevenly brown above, pale below; tibiae brown with a pale transverse band through the middle; tarsi brown with a pale transverse band at the proximal end. Fore-femur (Pl. VII, fig. 5) shorter and thicker than the others and with its anterior margin unevenly toothed. Anterior edges of the other femora entire. Upper surfaces of all the femora with wart-like elevations; posterior edge of the first femur and anterior and posterior edge of the other femora with a row of sparse hairs. Abdomen with gills present on segments 3-8, without Elytroid cover, superior lamina entire; inferior lamina bifid fimbriate. Segments 2-7 with a median double row of spines; posterior margins of segments 1-7 and 9-10 edged with short hairs; posterior margin of segment 8 with numerous longer hairs. The posterior lateral angles of segments 3-10 produced backward into flat-pointed spines. Setae 3, with numerous hairs on their outer and inner margins.

Ephemerella rotunda, sp. nov.

(Pl. VI, fig. 1; Pl. VII, fig. 3; Pl. VIII, fig. 5; Pl. IX, fig. 6.)

Occurrence, habitat. This species was taken in portion of Pleasant Brook, where there was little water and that strongly tainted by pipe drains. But four nymphs were captured. The two which were successfully reared proved to be females. The dates for their rearing were June 8 and 10.

	Measurements	
	Length of body	Length of setae
Female imago	10.5 m. m.	14 m. m.
Female subimago	10 m. m.	10 m. m.
Nymph	10.2 m. m.	6 m. m.

Female imago. Thorax luteus; legs luteus or whitish; abdomen brown; setae luteus with very distinct brown joinings. Head parchment color. Thorax, above, luteus slightly darker on the mesothorax; pleurae luteus to whitish with brown edges. Axillary cords (Snodgrass, '09, The Thorax of Insects and the Articulations of the Wings, p. 553) of the fore-wing prolonged into slender acute spines which project backward on either side of the hinder lobe of the mesothorax. Axillary cords of the hind wings prolonged in similar but less prominent spines. Wings hyaline, costal region sub-hyaline (Pl. IV, fig. 6); abdomen brown, pale at joinings and beneath. Color evidently mostly due to contained ova. Sternite one longer than those following; ster-

nite 7 with its posterior portion overlapping sternite 8 and with its posterior margin bilobed. Setae 3, nearly equal length, pilose; color pale luteus with distinct brown rings at the joinings.

Female subimago. Wings sub-hyaline and veins brown. Segment 7 not bilobed as in the imago.

Nymph (Pl. VI, fig. 1; Pl. VII, fig. 3; Pl. VIII, fig. 5). Head and body rounded and smooth, and without tubercles. Legs small in comparison with the size of the body. Head, rounded and without elevations (Pl. VI, fig. 1). The left maxilla is shown on Pl. III, fig. 5. Thorax, above smooth. Color, mottled brownish without definite markings. Prothorax wider than the head its lateral margins slightly flaring, and its width equal to that of the mesothorax; metathorax concealed from above. Legs weak, the femora poorly developed and with a row of hairs on its posterior margin (Pl. VII, fig. 3). Abdomen, above rounded, gills present on segments 3-7, the posterior margins of segments 4-9 with a double median row of small spinose elevations; segments 3-9 with their posterior lateral angles produced into flat spines whose margins are spinose serrate. Setae brownish indefinitely banded with whitish; basal joinings with circlets of hairs.

Ephemerella cornuta, sp. nov.

Occurrence, habitat. This, before mentioned species, was reared at Salisbury, Connecticut. The dates given by Miss Smith for its capture and rearing are July 20, 21. But two stages, those of the male sub-imago and the nymph are represented.

	Measurements.	
	Length of body	Length of setae.
Male subimago	10.5 m. n.	
Nymph	10 m. m.	6. m. m.

Male subimago, general color pale luteus with annular bands of brown on the abdomen. Eyes prominent. Head with ocelli white, encircled with broad bands of blackish brown; carina, frons and occiput pale; antennae light brown. Thorax, above pale luteus; the prothorax irregularly streaked with brown. Axillary cords of the fore-wing produced into a slender point extending backward on either side the median lobe of the metathorax, such prolongations not evident in the hinder wing. Legs, pale, the fore femora lightly shaded with brown. Wings, sub-hyaline, brownish at the base (Pl. IX, fig. 5). Abdomen pale whitish, with annular bands of brown shading. Setae 3, whitish.

Nymph. Body slender, and tapering from the mesothorax. Fore femora shorter and wider than the others and with its anterior margin unevenly toothed (Pl. VII, fig. 6). Head, with prominent incurving horns just below the antennae; general shape sub-quadrangular with the posterior angles rounded, and the frontal margin fringed with hairs and projected forward; origin of the antennae partly hidden by the curving ledges at the bases of the horns (Pl. VI, fig. 3). (Left maxilla

shown on Pl. VIII, fig. 6.) Thorax, mottled brownish; prothorax quadrangular, its angles closely fitting to the mesothorax. Legs with the margins of the second and third femora entire; the first femur figured on Pl. VII, fig. 6. Abdomen, rounded above, flattened below; without dorsal spines or tubercles. Gills on segments 3-7; posterolateral angles of segments 3-9 produced into flattened spines becoming more acuminate posteriorly; posterior margins of segments 2-10 sparsely edged with hairs; lateral margins of segments 3-9 spinose serrate. Setae, pale, except for a single brown ring at the base of each.

Tricorythus allectus Needham.

This species was described by Prof. Needham in Bull. 86, N. Y. State Mus. as Caenis allecta, but afterward referred by him to the genus Tricorythus, in Bull. 124 N. Y. State Mus.

Occurrence, habitat. These nymphs are closely associated with Caenis, though they have not thus far been often found in the ill smelling mud generally preferred by that nymph. They clamber about in fine silt and sand, and the particles which adhere to their hairy bodies make them practically invisible. A handful of mud which appears to contain no sign of life, will after a few minutes draining, reveal slowly moving bits of mud which may prove to be either Caenis or Tricorythus according to the quality of the mud. Tricorythus allectus is one of the commonest species in Fall Creek. During June and July, the imagoes may be found strewn upon the surface of little protected inlets along its shores, or caught in the meshes of the spider-webs on walls and bridges near it.

Measurement. Length of body 6.5 m. m. Length of setae 4 m. m. Mouth—parts and gill lamella (Pl. XI.) The nymphs of Tricorythus may be at once distinguished from those of Caenis by the shape of the elytroid gill cover, rounded at the end in Caenis, distinctly triangular in Tricorythus (Pl. XI, fig. 1). Color yellowish, pale below; abdomen marked with transverse bands of brown broken by a median longitudinal pale stripe. Elytroid lamella prominent, purplish brown at the base. Body all over sparsely beset with hairs. Antennae pale with basal segments brown. Legs pale with a blackish spot at the proximal joint of each tibia. Gills not wholly hidden by elytroid lamellae. Lateral spines on segments 2-9. Setae 3.

Caenis.

This genus is plentifully represented by Caenis hilaris, Say, and by nymphs of some other species not yet reared here.

Chirotonetes albomanicatus Needham.

Occurrence, habitat. Nymphs of this abundant species were found full grown in the dashing waters of the falls and riffles from the latter part of May to August 12th. In May they were seen to emerge in greatest numbers during the late afternoon and twilight. They crawled up on the shore leaving their cast skins clinging to the stones or less often they flew up directly from the mid current. The dark wings and body and the white forelegs of the sub-imago made it very conspicuous as it rested upon the gray stones or flew upward. Robins made a regular custom of coming to the shores and collecting the insects as they emerged. From four to six nymphs might be often seen projecting from their beaks.

Siphlurus alternatus Say.

This elegant species has been found to be very desirable for the indoor aquarium. It lives in still pools and demands only a minimum supply of fresh water and plenty of plant food. It was common all through April, May, and a portion of June. Nymphs kept in the laboratory aquarium nearly all lived to emerge and doubtless could have been kept there several months had they been taken early enough.

Baetis pygmea Hagen.

This species has been found chiefly interesting for its habits of egg-laying. From early June to late August the stones in the waters of the creek were covered with small elongate egg-patches rounded at one end, narrower and sharply squared off at the other. Plate XII, fig. 1 shows a stone about seven by ten inches in size on which the egg masses were scattered with average abundance. The surface upon which the eggs rested was the down-stream side of the stone and that portion where they were thickest was nearest to the surface of the water. On the same plate (fig. 2) is shown a photograph in which the patches are enlarged sufficiently to show the individual eggs. The laying of the eggs may be seen if one closely watches some stone which is marked as a favorite site by the presence of many masses. The following observation was made through an ordinary reading glass, but the processes may be easily seen with the naked eye.

Flying close to the surface of the water, the insect alighted on a stone projecting slightly from the water and well protected from the force of the current on its downstream side. She

immediately walked to the protected side and downward to the water. First, wrapping her wings about the abdomen, she made several attempts to immerse her head and thorax. This appears to be the critical stage of the performance, for many females are washed from the stone while attempting it. Once beneath the surface she started on a tour of inspection for the proper surface. This tour lasted for several minutes during which time she continually walked to and fro, pausing, feeling with the abdomen, and passing on unsatisfied. When a suitable place was finally found she braced her legs firmly, bent the abdomen downward, curved the setae upward and pressed the openings of the oviducts closely to the surface. The whole abdomen was then swung from side to side with a slow pendulum-like motion, each stroke leaving an irregular row of minute white eggs adhering to the surface. The strokes were at first somewhat circular and longer than those which followed. As the egg mass grew in length the insect moved forward a little to allow the eggs to lie in succeeding rows. When the egg supply was exhausted she stopped with a jerk of the abdomen and proceeded to clamber out of the water. When examined in the laboratory the abdomen of this female was found to contain only a few undeveloped eggs in the ovaries and none in the oviducts.

Ameletus ludens Needham.

Occurrence, habitat. In Pleasant Brook on April 25 nymphs of Ameletus ludens, were found in great abundance resting upon the bottom or darting about much like the nymphs of Callibaetis. They were the dominant insect of the stream at this time. One soft bottomed pool about four feet long, and two wide yielded about 300 nymphs in half an hour's collecting, and many more remained. Full grown nymphs were placed in cages for purposes of rearing. The female subimago was found to correspond with Prof. Needham's description given in Bull. 86 of the N. Y. State Mus. Attempts were then made to secure a male to add to the life-history since Prof. Needham was unable to procure one. The results of the rearing were as follows:

April 29,	1 nymph emerged,	transformed	April 30.	Female.
April 30,	1 nymph "	"	May 1.	"
May 7,	1 nymph "	"	May 8.	"
May 8,	3 emerged nymphs,	"	April 9.	"

Repeated rearings failed to secure a male specimen. An enclosure was then made in a neighboring rill by means of boards

and fine meshed wire-cloth. Over this, a cheese-cloth tent was erected, and in it a large number of nymphs were placed. The records of the results obtained are as follows:

May 8, 12 nymphs emerged before 12 M., transformed before May 9, 12 M. All Females.
May 10, 40 " " before 12 M., " before 12 M., May 9. All Females.
May 12, 25 " " before 12 M., " May 13, before 12 M. All Females.

That these nymphs emerged so regularly before noon was doubtless due to the fact that the sunshine reached the tent only at this time and in the late afternoon. Rearings were made as long as the season lasted but neither among the reared specimens nor among the nymphs collected could a male be found. A few specimens of the same species were also collected in two other streams near Ithaca, but no males were found. The fact that no male specimens have been taken neither in collecting, or rearing, indicates a case of parthenogenesis in this species.

Female imago. Measurements. Length of body 10 m. m. Length of setae 10 m. m. Color bright reddish brown with whitish areas on the thoracic pleurae. Abdomen reddish brown slightly paler beneath with the ventral ganglia marked by darker areas. Antennae brown, paler at the base, the second segment very long. Thorax brown; legs brown, the third pair slightly paler than the others; wings hyaline with their bases shaded with brown and the veins very distinct. Setae brown with their joinings distinctly lined with brown.

SUMMARY.

1. The physical features of Fall Creek make possible the greatest variety of aquatic conditions. A study of the abundant May-fly fauna which lives under these conditions has revealed a series of striking adaptations to environment.

2. One may best observe the nymphs and secure adults of uncommon species by rearing the insects in their own surroundings. For this purpose a new type of breeding cage has been described and figured.

3. Observations upon representatives of 17 different genera have shown some interesting points in structure and ecology. Among these have been described the structural adaptations of various nymphs, the striking peculiarities of Ephemerella nymphs, the emerging of Blasturus cupidus, the swarming of Ephemera and Leptophlebia, and the egg-laying of Baetis.

4. No male specimen of Ameletus was secured either by collection or among 83 reared specimens. I have, therefore, suggested that this species may present a case of parthenogenesis.

EXPLANATION OF PLATES. (All figures much enlarged.)

PLATE VI.

Heads of **Ephemerella** nymphs.

Fig. 1. Ephemerella rotunda sp. nov.
" 2. " tuberculata "
" 3. " cornuta "
" 4. " deficiens "
" 5. " serrata "
" 6. " lata "

PLATE VII.

Legs of **Ephemerella** Nymphs.

Fig. 1. Right legs of Ephemerella lata sp. nov.
" 2. " foreleg " " serrata "
" 3. " " " " rotunda "
" 4. " " " " deficiens "
" 5. " " " " tuberculata "
" 6. " " " " cornuta "

These drawings are all made from the upper or dorsal aspect. The enlarged sketches of the claw and tarsus of each show the ventral aspect of the tarsus with its chitinous comb which is used in clinging to the rocks.

PLATE VIII.

Mouth-parts of **Ephemerella** nymphs.

Fig. 1. Mouth-parts of Ephemerella lata. sp. nov.; r. md., right mandible; l. md., left mandible; lr., labrum; l., labium; mx., left maxilla; hy., hypopharynx, viewed from above.

Fig. 2. Left maxilla of Ephemerella serrata sp. nov.
" 3. " " " " tuberculata "
" 4. " " " " deficiens "
" 5. " " " " rotunda "
" 6. " " " " cornuta "

PLATE IX.

Epeorus and Ephemerella.

Fig. 1. Epeorus humeralis sp. nov. Portions of the 3rd and 4th abdominal segments of the nymph with gills removed, to show lateral spines.

Fig. 2. Forceps and penes of Epeorus humeralis, sp. nov. (From below.)
" 3. " " " " Ephemerella serrata sp. nov. (From below)
" 4. " " " " " deficiens " (From below).
" 5. Wings of " cornuta "
" " " " rotunda "
" 7. " Epeorus humeralis "

PLATE X.

Iron fragilis sp. nov.

Fig. 1. Mouth-parts of the nymph; 1, outer aspect of the labium; ll., inner aspect of the labium; r. md., right mandible; l. md., left mandible; hy., hypopharynx.
Fig. 2. Wings.
Fig. 3. Foreleg of the male imago.
Fig. 4. Forceps and penes from below; dotted lines represent the portion of the penes hidden by the last sternite.

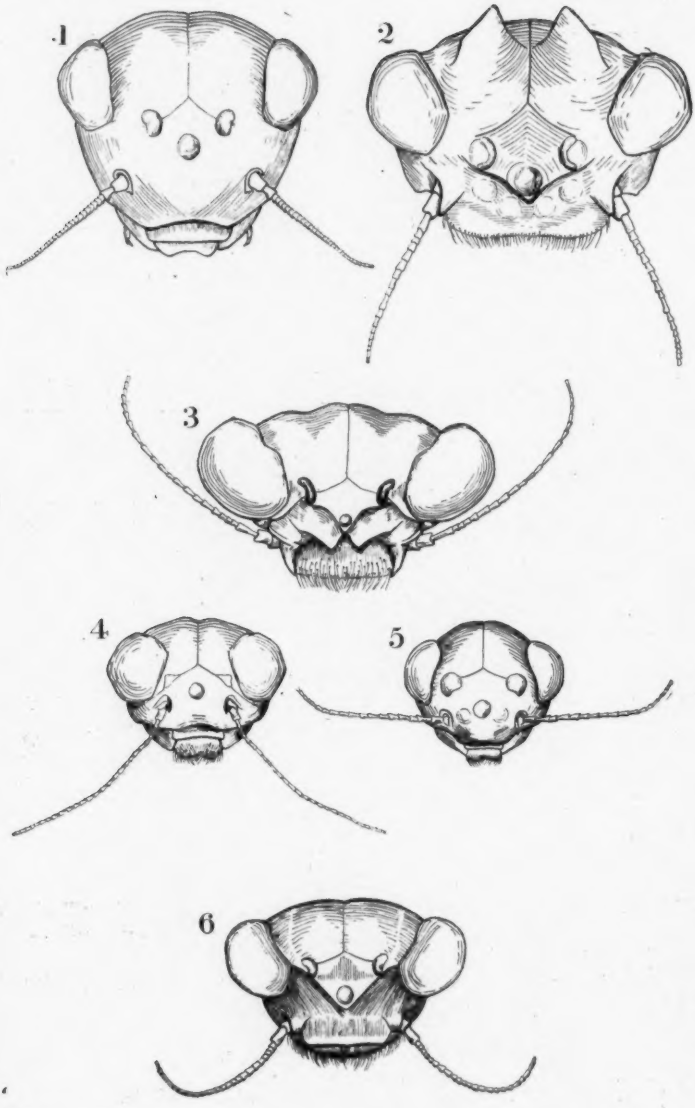
PLATE XI.

Tricorythus allectus Needham.

Fig. 1a. Elytroid lamella; hy., hypopharynx;
" lr. labrum; r. md., right mandible; l. md., left mandible.
" mx. left maxilla; l., labium.

PLATE XII.

Fig. 1. Surface of stone covered with masses of Baetis eggs.
" 2. A few of the masses enlarged.



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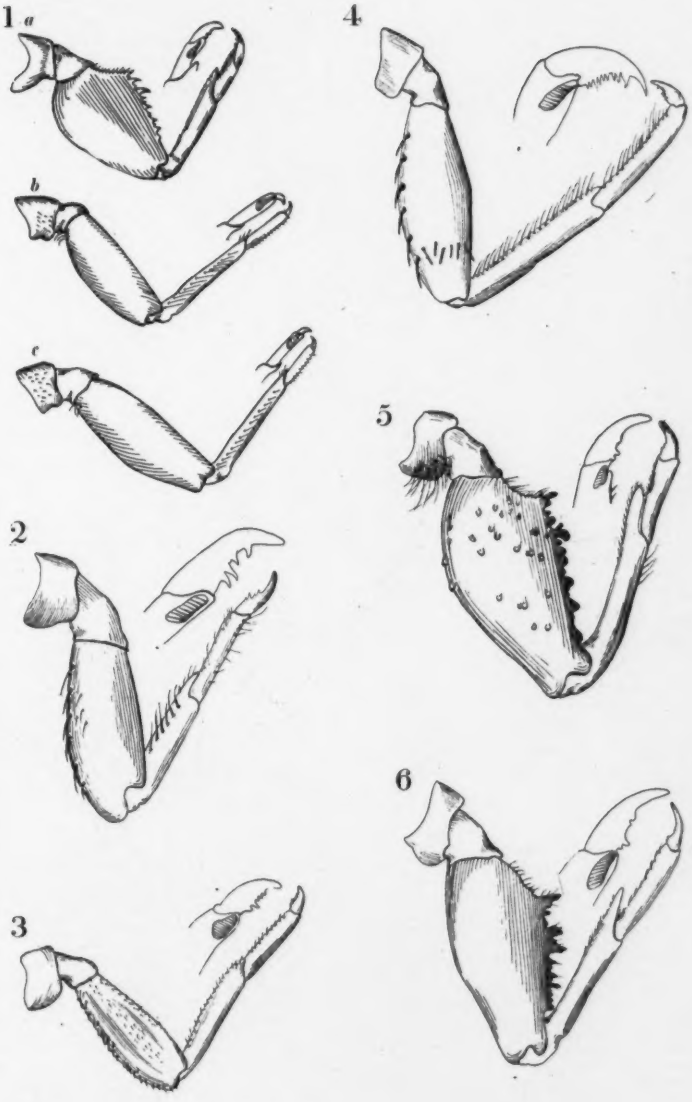

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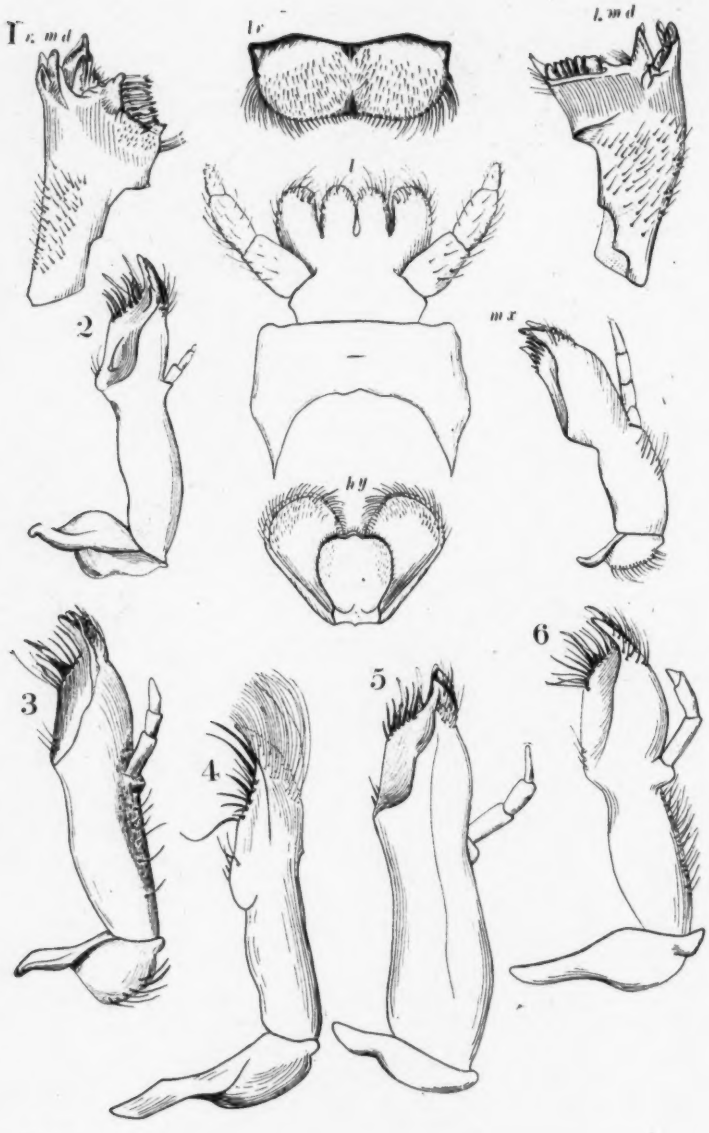
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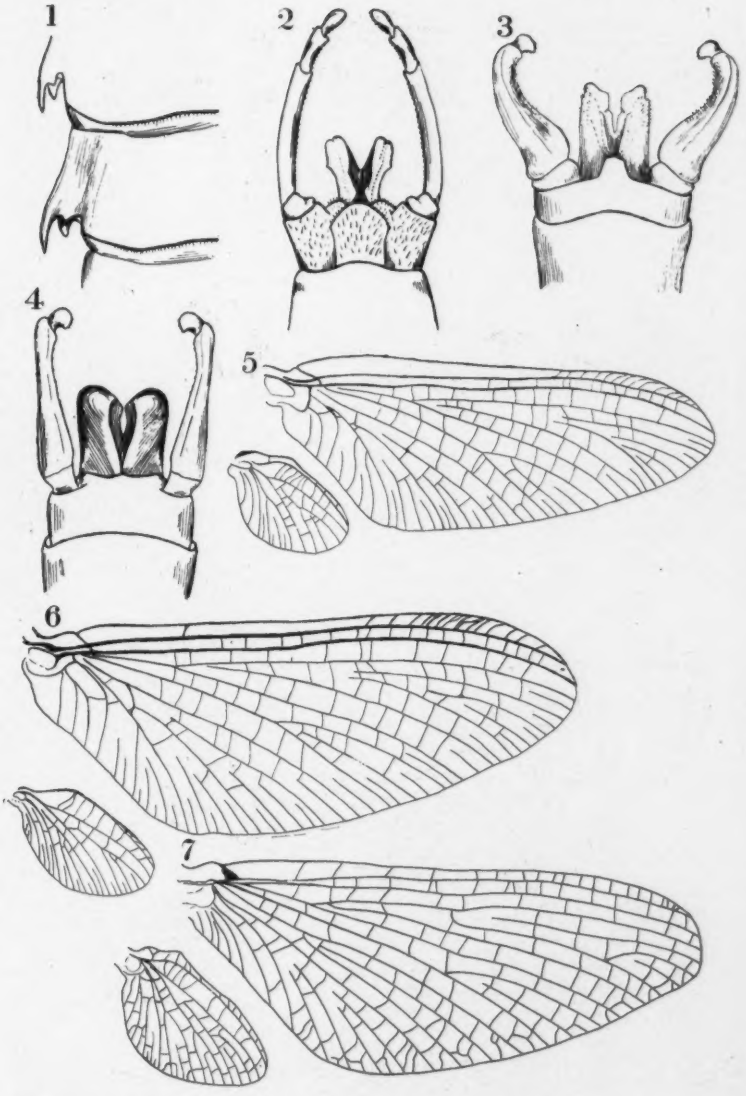

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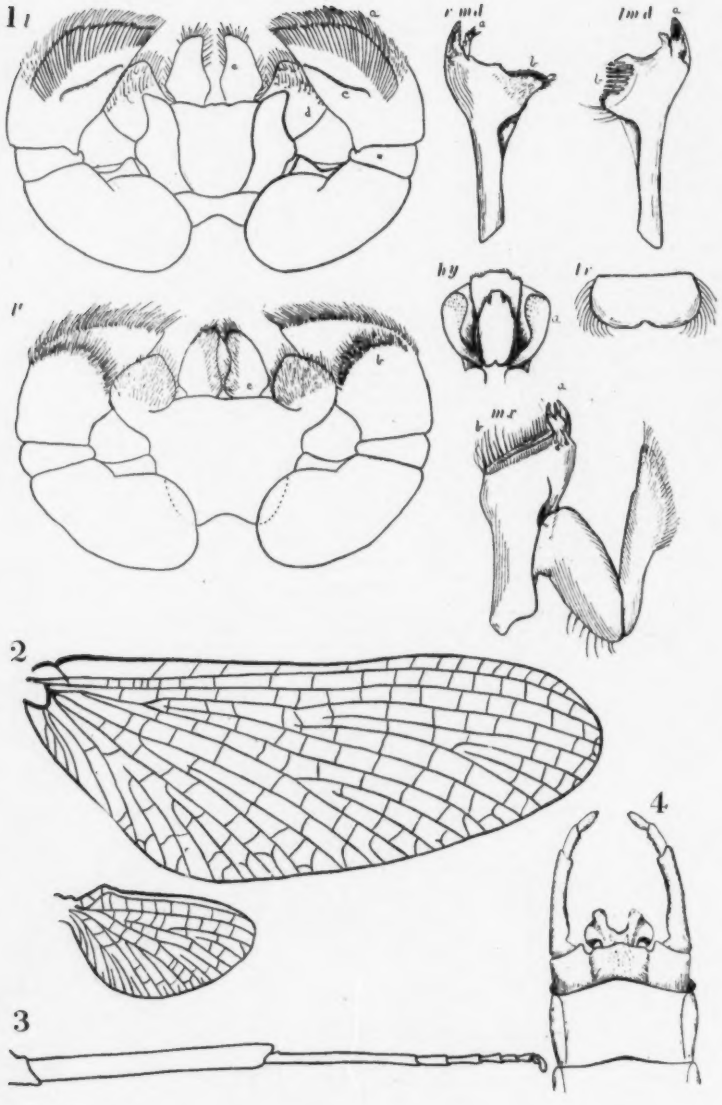
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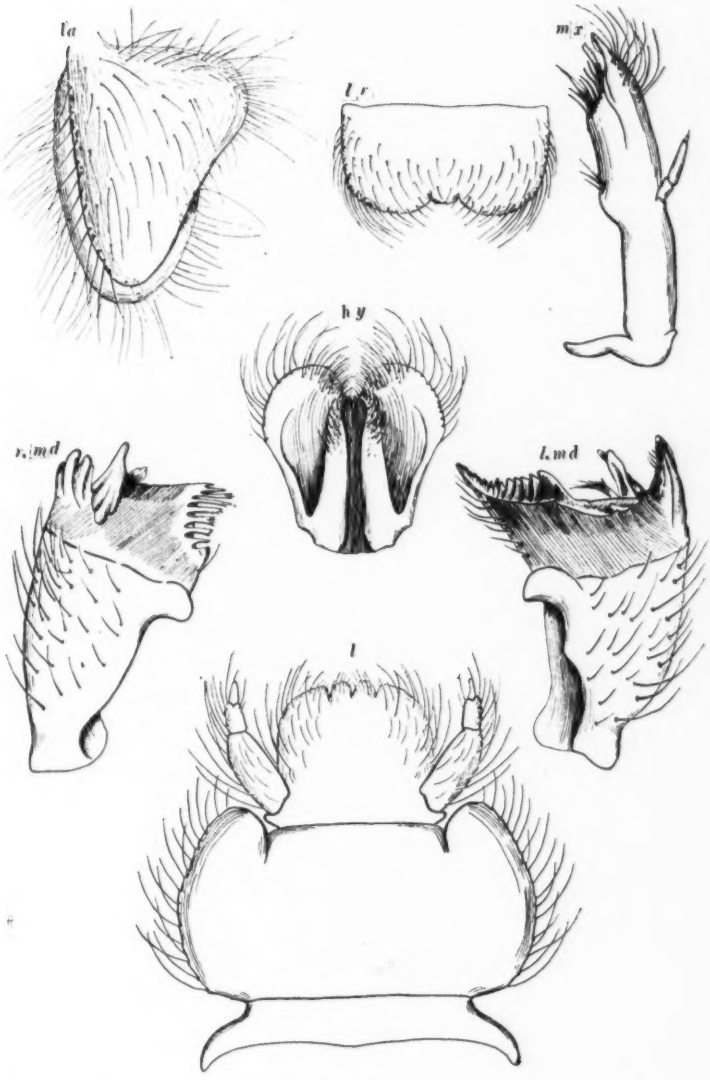

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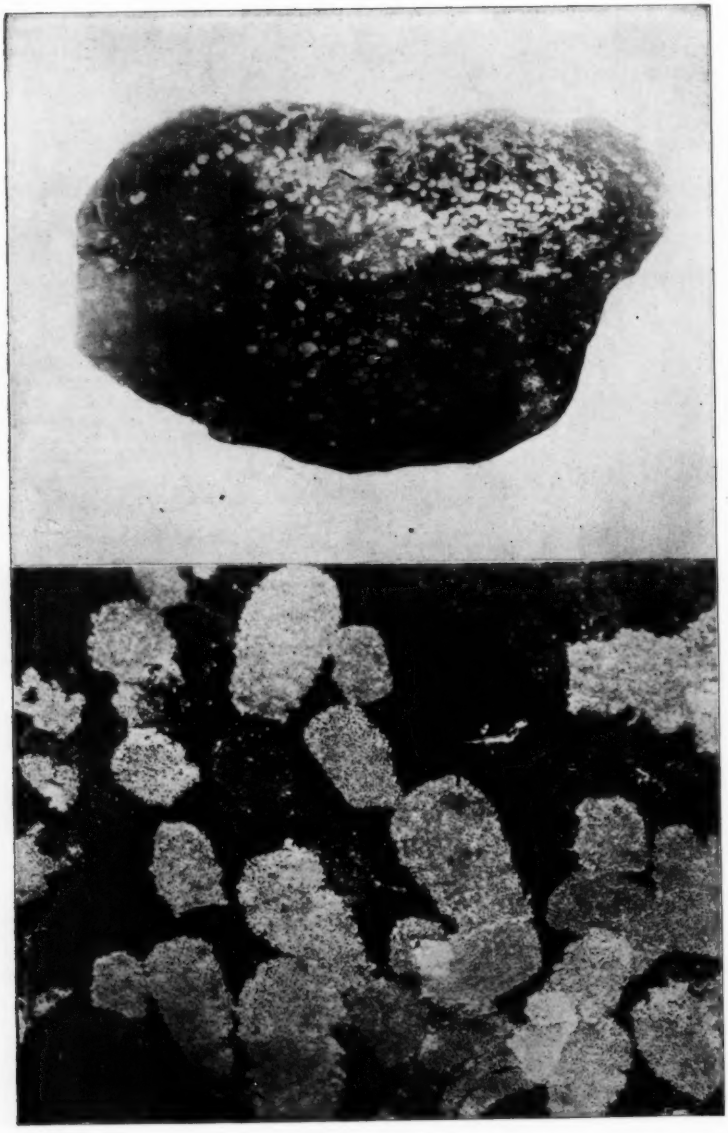

A. H. Morgan.

ANNOUNCEMENT OF FURTHER RESULTS SECURED IN THE STUDY OF MUSCOID FLIES.

By CHARLES H. T. TOWNSEND,
Piura, Peru.

The work on the female reproductive system, eggs, and first-stage maggots of the Tachinid flies and their allies, begun in 1908 by the writer at the Gipsy Moth Parasite Laboratory in Massachusetts, under the direction of Dr. L. O. Howard, Chief of the Bureau of Entomology, has been prosecuted to date as time permitted. The results are now such that it becomes desirable to make an announcement of them in brief. This announcement is in advance of a series of much more complete papers, which will contain plates of the female reproductive and accessory organs, eggs, first-stage maggots, and cephalopharyngeal skeletons of the latter, some 200 drawings having already been completed for this purpose.

The female reproductive and accessory organs in the Muscoid flies consist of (1) ovaries, (2) oviducts and common oviduct, (3) spermathecae and their ducts—3 in number, (4) tubular (or colleterial or accessory) glands and their ducts—2 in number, (5) uterus when present, including what may be termed the preuterus which is present in some forms, (6) uterovagina, being a vagina proper which functions anteriorly as a true uterus when latter is absent, and (7) ovipositor or larvipositor and appendages.

The functions of most of the above organs are generally understood, but the following points need mention:

The tubular glands function as secretory organs for the production of the viscid fluid for coating the eggs, and are more or less rudimentary in those forms that deposit maggots; the preuterus is a small sac at the head of the uterus, in which the egg of some forms is fertilized before passing into the uterus proper, the spermathecal ducts opening into it; the uterovagina is a short tube homologous with the so-called insect vagina, its anterior portion filling the office of uterus in those forms without distinct uterus, the spermathecal and tubular gland ducts opening therein, its posterior end filling the office of vagina. The openings of the spermathecal ducts always mark the transition from common oviduct to functional uterus.

The results so far secured in the present work indicate at least 37 distinct series in the Muscoid flies (exclusive of Anthomyiidae and Acalyptratae), based mainly on the characters of the reproductive and accessory organs of the female fly, the egg, first-stage maggot, and in some cases the facial plate and other characters of the external anatomy of the adult. Undoubtedly further work will demonstrate the existence of further series demanding recognition. Briefly the series so far recognized may be tabulated as follows:

1. TRICHOPODINE series—Xanthomelanodes peruanus n. sp. (Peru) dissected and drawn, TD 3983. No uterus, uterovagina short and broad, tubular glands short and thick, spermathecal ducts very long and spermathecae attached in hood, oviducts of moderate length and thickness, ten eggtubes in each ovary in the above species, eggs flattened and pink-salmon to flesh-brown in color when mature. The chorion of egg is beautifully honey-comb reticulate. Xanthomelanodes and allies. Trichopoda and allies, many of which have been dissected, have same eggs and ovaries, and almost certainly the same type of reproductive system.

2. RUTILIINE series—Rutilia sp. and Amphibolia sp. (Australia) dissected, TD 1864, 1866. Uterus present, but its character not yet known. Maggots long and slender, hairy or furnished with hairs at anal end. Rutilia maggot has anal hairs, Amphibolia maggot is thinly hairy on body. Rutilia, Amphibolia and allies—Australian flies, most of rather large size. These will probably need division into several series.

3. PHASIINE series—Uterus present, form not known. Egg very elongate, slender, TD 480 (South Carolina), near Alophora, has what seems a piercing larvipositor or ovipositor, but curved in the opposite direction from that of Compsilura and not so sharp apically. Phasia, Alophora, Hyalomyia and allies, but these have yet to be studied.

4. GRAPHOGASTERINE series—Hyalomyodes sp. (South Carolina) dissected, TD 481. Uterus present, eggs and maggots slender. Hyalomyodes and allies, and probably Anurogyna.

5. GLOSSININE series—Functional uterus, whether uterus proper or uterovagina, greatly enlarged to hold the maggot until fully grown and ready to pupate, some special provision being evidently present for the feeding of the maggot during

its three stages. A most remarkable and distinct type, in any event, not only in its reproductive system and habit, but also in its venation and other characters. Glossina and allies—African blood-sucking flies, carriers of Trypanosomae of various forms of sleeping sickness in man and animals.

6. STOMOXYDINE series—Stomoxys calcitrans (Peru) dissected and drawn, TD 3985. No uterus, uterovagina short, spermathecal ducts long and doubled, tubular glands fairly well developed but not longer than oviduct plus common oviduct. Eggs elongate and deposited on dung. Adult with piercing mouthparts in both sexes. Ovipositor with a dorsal pair of bristly, slightly curved, subcylindrical chitinous processes. Stomoxys, and probably Lyperosia, Haematobia and allies—blood-sucking flies and probable carriers of microzoa of certain cattle diseases.

7. CALLIPHORINE series—Compsomyia macellaria (Peru) dissected and drawn, TD 3984. No uterus, uterovagina very short; spermathecal ducts very short, only as long as the spermathecae themselves; tubular glands only very moderately developed, about as long as common oviduct plus oviduct, the latter hardly half the length of the former. Ovipositor simple. Mouthparts fleshy. Eggs elongate, deposited in sores or on meat, the product of both ovaries being deposited at one time. Compsomyia and allies, and probably Calliphora, Lucilia and allies.

8. MESEMBRININE series—Probably a distinct series comes here, including Mesembrina and allies, and especially Dr. Adolf Lutz's strange Brazilian fly which Prof. Hermann determines to be Pseudogametes, and which seems to have Mesembrinine affinities.

9. MUSCINE series—Musca domestica (Peru) dissected and drawn, TD 3982. No uterus, uterovagina elongate; a pair of uterovaginal pouches springing from lateral anterior walls, one on each side below insertion of spermathecal and tubular gland ducts, being accessory copulatory vesicles of Hewitt; tubular glands long and slender; eggs elongate, deposited on dung, etc. Musca and allies.

10. SARCOPHAGINE series—Sarcophaga 2 spp. (Peru) dissected and drawn. Uterus, when distended, heart-shaped or cordate, maggots rather irregularly disposed therein. Uterovagina short, but with two dorsally-lying sacs or large pouches

developed from its anterior ventrolateral walls, one on each side, these two sacs and the uterovagina together forming the heart-shaped functional uterus, which contains the eggs until the embryo has developed to the fully formed maggot ready for deposition on host or food-substance. Sarcophaga and allies; and possibly Rhinophora, Melanophora, Brachycoma and allies, the last three genera being included by external anatomical analogy. Brachycoma is a Bombus inquiline or parasite; Rhinophora and Melanophora are terrestrial-isopod parasites.

11. METOPIINE series—Metopia sp., TD 3988; Selenomyia sp., TD 3998; Sarcomacronychia sp., TD 3996 (all Peru) dissected and the first drawn. Uterus thick short V-shape, the arms of the V being productions anteriorly of the ventral walls of the uterovagina on each side, on the same plan as that of Sarcophaga but in different form, not rounded but rectangular pouches, the form doubtless due largely to regular disposition of the contained eggs and maggots; spermathecal ducts very long, doubled on themselves; tubular glands thick and moderately long. Maggots and eggs regularly arranged on end in uterus in triple and quadruple file. The uterovagina forms the base of the V, thus functioning as part of the uterus; the empty arms appear as blind tubes. Metopia, Selenomyia, Sarcomacronychia and allies. It is to be noted that the facial plate in the adult of Metopia is widely different from that of the rest of the group, probably due to antennal development, thus indicating its inferior rank in this series. Largely muddauber-wasp inquilines or parasites, feeding on contents of nests. Related to the Sarcophagine series.

12. COMPSILURINE series—Compsilura concinnata (Europe), Dexodes nigripes (Europe), Vibrissina sp. (Florida), and Eucelatoria spp. (Florida and Peru) dissected; TD 290, 132, 775, 1229, 3906. Uterus slender, long, in several coils, maggots and eggs normally obliquely on end, the maggots usually in single file, deposited subcutaneously in host through the hollow curved piercer of female fly, the single file arrangement doubtless for the purpose of facilitating the passage of maggots through the piercer. This type is a modification of the Hemimasiceratine type, with the addition of a piercing larvipositor for subcutaneous deposition of the maggots. Compsilura, Vibrissina, Eucelatoria and allies, including so far as known all flies whose females are provided with a curved piercing sharp-pointed larvipositor.

13. TACHININE series—Tricholyga sp. (Peru) dissected and drawn, TD 3971. Tachina spp. (Europe, America and Japan) dissected. No uterus, uterovagina normal and capable of holding but few eggs at a time; eggs oval and flattened, provided with a terminal dorsal hinged lid or cap for exit of maggot, normally deposited in a comparatively undeveloped state of embryo on host. Tubular glands very long and highly functional. Chorion hard, opaque, not reticulate. Tachina, Tricholyga and allies. Everything here points to egg deposition, and it is thus difficult to understand Dr. I. C. Nielson's record of larviposition for his Tachina larvarum, female flies of which appear to be the same as the ordinary form from which we secured deposition of great numbers of eggs but never a maggot, at the Gipsy Moth Parasite Laboratory.

14. MEIGENIINE series—Eumyothyria sp. (Peru) dissected and drawn, TD 3981. Uterus in a single coil, tubular and thickened when full of eggs; egg oval and flattened like that of Tachina, maggot developing within egg in uterus certainly to some extent, but egg evidently deposited on host after a certain period of uterine incubation. The flat eggs exhibit a shingled arrangement in the uterus. The long well developed tubular glands show that the eggs are intended for deposition as such, before the escape of the maggot. Both tubular glands and eggs are practically same as in the Tachinine series. Eumyothyria and quite certainly Meigenia and allies. TD 651 (Florida) with small brown flat eggs, which were certainly uterine, and TD 738 (Ocean Beach, So. Florida), with Plagia-like venation and small flat uterine eggs may possibly come here.

15th series—Apparently what Coquillett determines as Sturmia distincta, which seems same as protoparcis Towns. and is probably referable to Zygobothria (Florida), TD 619; and other spp. (Europe and Florida) dissected. Short coiled strap-like uterus full of maggots and eggs on end, after style of Hystriciine series (which follows) but in only two or three coils and with white maggots which are evidently deposited on hosts, being without anal membraneous pad for leaf-attachment. Zygobothria and allies, provided Z. bimaculata Htg. of Europe, the type of the genus, agrees herein as it seems to in external characters. Type specimens of many genera will have to be dissected before we will know what name to give this series.

16. HYSTRICIINE series—Archytas sp. (Peru) dissected and drawn, TD 3989; and Melanophrys, Varichaeta, Copecrypta, Echinomyia, Jurinia, Paradejeania, Dejeania, Saundersia, and many others dissected and their maggots drawn. Very long coiled strap-like uterus, in many coils, band-like, wide and thick, full of eggs and maggots on end, the thickness of the uterus corresponding to the length of the maggots and eggs contained, but the uterus lying on edge in a spiral like a watch-spring; maggots developing therein and becoming dark colored when mature from the blackish dorsal and lateral minute scale-like plates, deposited on the foliage of plants in proximity to their hosts, being furnished with an anal membranous attachment pad for adhering to plant surfaces. Tubular glands short and small. The above named genera and their allies, forming a very large and predominant series especially in the mountainous regions of both Americas, and representing the most recent phase of Muscoid fly evolution. This series will need to be divided into several groups.

17. MASICERATINE series—Blepharipa politana n. sp. (Peru) dissected and drawn, TD 3977; others dissected and their maggots and eggs drawn. Very long coiled tubular slender uterus, in many coils, filled with thousands of microscopic eggs which are held till the contained maggots are fully formed when they have become black in color and are deposited on foliage to be swallowed by hosts in feeding, being placed in proximity to leaf-eating insects, probably always lepidopterous larvae. Tubular glands moderately thick and developed. The chorion of the egg in this series exhibits always a honeycomb-like or network system of reticulation, though often also showing minute light-colored points appearing as microscopic punctures. The chorion of egg is oval in outline viewed from above. TD 877 (So. Florida), the adult of which at first sight appears much like Cnephalia, has the egg-substance protruded beyond the chorion at both ends, giving the eggs a decidedly slender and pointed appearance especially when seen in situ through the walls of the uterus. The explanation of this peculiarity has yet to be learned. The series includes Masicera, Blepharipa, etc., forming with other leaf-ovipositing flies a large group more especially predominant in the lowlands of both Americas as well as other parts of the world, and representing an extreme phase of Muscoid fly evolution somewhat less recent than that of the Hystriciine series.

18th series—Species agreeing in external characters with Eumasicera but certainly not that genus (Peru), TD 3987; dissected; probably Exorista futilis O. S., determined in the adult by Mr. W. R. Thompson (Massachusetts), TD 344, 361. Uterus short, thick, tubular, in only two or three coils, filled with microscopic oval eggs of same character as those of Masiceratine series except that they show no honeycomb or network reticulation but a concentric-ring or concentric-arc pattern viewed from above, apparently due to a disposition of ridges or wrinkles in the chorion. Eggs deposited on foliage, probably for lepidopterous larvae only. The above mentioned forms must, I think, belong to the same genus as the reticulation of the chorion is of the same character; but until the type species of Exorista, Sturmia, and various other genera are dissected, it will be impossible to say what generic name must be given them; and still further genera must be dissected before we can know what name to give this series, which may include Phorocera, or even older genera. TD 437, which seems referable to Phorocera on external adult characters, probably comes in this series; it is European.

19th series—Ophirosturmia cincta gen. et sp. nov. (Peru) dissected and drawn, TD 4012. Uterus tubular and elongate in four to six coils, stouter near head, filled with microscopic oval brownish-yellow to yellow-brown eggs, whose choria exhibit a honeycomb reticulation, the eggs deposited on leaves in proximity to certain leaf-eating insects. There is no punctulation to the chorion. Distinguished from the Masiceratine series by difference in spermathecal ducts, and by the brown-yellow color of the mature eggs, as well as other points. Apical cell ending well before wing-tip.

There are other series yet to be defined among the leaf-ovipositing forms.

20. GYMNOCHAETINE series—Gymnochaeta sp. (Peru) dissected, maggot drawn, TD 3973. Maggots and eggs on end in two or three rows in very long subtubular coiled uterus; maggots black by reason of the body segments bearing a large dorsal and two small lateral colored plates, these made up of minute colored scale-like plates of different form from those of the Hystriciine series; the maggot with ventral locomotory spine-pads and spine-rows composed of very microscopic spines and evidently specially fitted for locomotion in the open; no anal

membraneous attachment pad being present. This is a totally new type of maggot and indicates a widely diverse habit from others so far known. Gymnochaeta and allies.

21st series—Ophirion mirabile gen. et sp. nov. (Peru) dissected and drawn, TD 3980. Maggots and eggs rather loosely disposed in long slender tubular uterus, the eggs in two rows obliquely on end; an elbow-like preuterus, uterus arising from inside angle of elbow, common oviduct opening into one end of elbow and the spermathecal and tubular gland ducts into the other end; oviducts long and slender, tubular glands very short; maggots of a peculiar and new type, remarkable in that they appear emarginate laterally and are furnished with a dark-colored pattern.

22. PSEUDODEXIINE series—Ophirodexia pulchra gen. et sp. nov. (Peru) dissected and drawn, TD 3999. Uterus thick, tubular, in two coils, with eggs and maggots obliquely on end; a true preuterus homologous with the forward half or more of the uterovagina, the uterus having evidently developed from the walls of the vagina proper; spermathecal and tubular gland ducts opening into the preuterus, which has capacity of just one egg; all these ducts very short; tubular glands only about three times as long as preuterus, or as long as common oviduct plus oviduct; oviducts very short and thick; common oviduct much longer and slender, being about twice length of preuterus. Maggots slender. Abdomen of fly elongate, subcylindrical; facial plate long, wide, not constricted by vibrissal angles, cut off abruptly below; antennae elongate, arista plumose. These characters apply to the above form, TD 3999. Ophirodexia and allies, including probably Pseudodexia, Leptoda, Cordyligaster, and a host of others. Atrophopoda may come here, or may be very distinct.

23. OCYPTERINE series—Probably a distinct series comes here for Ocyptera and allies. The genus has been dissected, but not with sufficient care. The eggs are elongate, stout, subcylindrical; maggot unknown to me.

24. THRYPTOCERATINE series—Probably a series comes here for Thryptocera and allies. Eggs slender, elongate. Maggot not known to me.

25. HEMIMASICERATINE series—Uterus present, doubtless coiled, containing elongate white maggots which must be deposited on host. Hemimasicera, Sisyropa and allies. These

genera dissected and maggots drawn, but the form of uterus was not determined.

26. SIPHOSTURMINE series—Siphosturmia sp. (Peru) dissected. TD 4002. Single-coil uterus, sub-tubular, with two rows of eggs and maggots; very long ovipositor, sub-chitinous, in its unextended position in abdomen measuring nearly one-half the length of uterus; ovaries slender, elongate, with few eggtubes; oviducts long, common oviduct same length as oviduct; spermathecae elongate-oval, two joined in hood, the third free; spermathecal ducts elongate, about as long as common oviduct; tubular glands moderately elongate and slender, about as long as common oviduct plus oviduct. Siphosturmia and allies. Florida specimens of the genus have also been dissected.

27th series—Anisia, Erynnia, Gymnostylia spp., or forms allied to these genera so far as can be known by external adult characters, including Hypostena barbata of Coqt. in part (Peru and Maryland) dissected, TD 4001, 433. Plump white maggots with well-developed spine rows on ventral surface. Uterus slender, tubular, coiled three times within itself; maggots in single file, oblique to nearly longitudinal in position according to degree of crowding in uterus; spermathecal ducts long, tubular glands not long; ovaries elongate, with few eggtubes. The maggots of the Peruvian form (TD 4001) show five highly developed ventral spine rows; those of the D. C. form (TD 433, collected by Knab on Plummers Island following a beetle of Calligrapha bigsbyana) are very similar, having five transverse rows of strong hooked spines on posterior half of median ventral surfaces. Maggots of TD 352 (Mass.) are short and plump, with strongly marked complete rows of spines encircling the body, and may not belong here; the fly has a different facies. The series embraces flies that are parasites of both the grubs and adults of certain beetles, especially Chrysomelidae. The European tachinid parasite of the imported elm-leaf beetle apparently belongs here. Many genera will likewise have to be dissected before this series can be named.

28. PAREXORISTINE series—Parexorista cheloniae (Europe) and Parexorista sp. (Mass.) dissected, TD 432. Uterus in a single coil, containing elongate subcylindrical eggs which are furnished with a pedicel, the eggs incubated in uterus sometimes to an advanced stage of the embryo and then deposited on host attached to skin or hairs of latter by pedicel. Parexorista and allies.

29. DEXINE series—Almugmyia arida gen. et sp. nov. (Peru) dissected and drawn, TD 3979. Dexia, Mochlosoma, Sirostoma, Sardiocera, and allied forms dissected and maggots drawn. Uterus thick, tubular, in one coil; eggs and maggots in a very oblique and somewhat spiral arrangement; ovaries very slender, elongate, consisting of few eggtubes; common oviduct rather long, oviducts short, spermathecal ducts long and doubled, tubular glands small. The maggots of Almugmyia and Sirostoma have anal spiracular tubes carried out in long slender anal processes which are tipped with bristles; the eggs of the first are sharply pointed anally, due to the presence inside the chorion of the anal bristles of the developing maggot. Probably the genera above mentioned all come in this series with many others, but the reproductive-system characters above given have not yet been verified for the genera other than Almugmyia. Parasites of white-grubs, woodboring-grubs, and probably others.

30. MYIOPHASIINE series—Ennyomma globosa (South Carolina and Florida) dissected, TD 509. The maggot is so slender as to be almost filiform. Uterus present, but form not determined. Ennyomma, Myiophasia and allies. Parasites of weevil grubs in green fruits.

31. PHASIOPTERYGINE series—Phasiopteryx spp. (Colorado, Veracruz and Peru) dissected, TD 1791, 1791a, 4005. Uterus present, very long and slender, in many irregular knot-like coils and turns, the upper part more regularly coiled, receiving the eggs while latter are still microscopic, the eggs growing to full size in upper part of uterus. Ovaries and oviducts very small, the latter not over one-fourth the diameter of a full-grown uterine egg. Preuterus present. Spermathecal ducts very short, tubular glands short. Maggots with five longitudinal rows of strongly chitinized segmental plates, those of median row wide and covering dorsum of segments, those of inner lateral row narrowed, those of outer lateral row presenting a serrate outline below; underside white and soft. The chitinized plates of the maggot vary from brownish-yellow to black, overlap when the maggot in contracted, the segments telescoping and producing a strongly emarginate outline both from above and in profile. These plates are evidently ambulatory in function as well as protective against conditions of life in the open or subopen. Maggots elongate when not contracted, moderate-

ly wide, flat below; wide and short when contracted. The habit is larviposition, but one can not even guess at the larval habit and host relation. This is a most interesting and remarkably distinct type. Although the Colorado and Veracruz specimens of the fly look quite alike externally, the maggots from the Veracruz specimen all show two large black bunches of strong more or less swollen and hooked or cleft spines on cephalic segment which are wholly lacking in the maggots from the Colorado specimen, indicating two very distinct species. The maggots from the Peruvian specimen do not show these cephalic spine-bunches; they besides differ from both the Colorado and Veracruz maggots in the characters of the segmental plates.

The Veracruz specimen came from Orizaba (coll. by Herbert Osborn) and is probably P. bilimeki B. B., the type of which came from the same locality. A much fuller description with figures of the maggots and female reproductive system will be given in forthcoming papers.

32. MEGAPROSOPINE series—Microphthalma spp. (North and South America) dissected, TD 313, 3915. Uterus present, long, subtubular, in several coils, filled with thousands of slender pointed eggs and maggots. The maggot of Microphthalma is very hairy, being the extreme development in this respect so far as known. This series includes Microphthalma and allies, and almost certainly Megaprosopus. Trixodes is almost certainly the type of a separate series. The first and probably the second are white-grub parasites, while Trixodes is probably a woodboring-grub parasite.

33. MACRONYCHNIINE series—No dissections of Macronychia have as yet been made. The uterus may well be Metopiine in form. At all events it must be quite distinct from the preceding series. The forms are perhaps muddauber-wasp inquilines.

34. CUTEREBRINE series—Cuterebra spp. (Florida and South Carolina) dissected, eggs drawn, TD 487, 486. Probably no uterus, as the eggs are certainly deposited; chorion of egg very thick and hard, furnished at what is probably cephalic end and with a hinged lid or cap opening on dorsal aspect of egg and provided for the exit of the maggot which could not otherwise escape from its heavy chorion-prison, thus demonstrating most conclusively that the egg is intended for deposition as such. Eggs probably deposited externally on skin or

hairs of host, and not swallowed, the maggots probably—almost certainly—penetrating skin at point of oviposition; Dermatobia hominis is practically known to have these habits. Cuterebra, Dermatobia, and probably Rogenhofera and Bogeria.

35. GASTROPHILINE series—Probably a uterus in which the eggs are incubated to a certain extent; eggs pediceled and perhaps ready to hatch soon after deposition, deposited on hairs of Equus and on Elephas, in the latter case probably on the hairs; maggots issuing from chorion in mouth or oesophagus of host and living in alimentary canal of same, passing out with the faeces when fully grown. Gastrophilus and probably Cobboldia, the latter parasitic in elephants in Africa and India.

36. OESTRINE series—Uterus certainly present; maggots deposited in nostrils of ruminants, elephant and horse, living in nasal and pharyngeal cavities and issuing through nostrils when ready to enter ground for pupation. Oestrus, Rhinoestrus, Cephenomyia, Cephalomyia, Pharyngobolus—last known only as maggot in pharynx of elephant in Africa.

37. HYPODERMATINE series—Peristomalia or facilia of adult fly remote, enclosing between them what seems to be the excessively broadened clypeus or epistoma, perhaps both differing in this character of the facial plate most widely from all the other Muscoidea. The sclerites of these parts need careful study before they can be rightly interpreted. Perhaps a uterus in which the eggs are partially incubated; eggs deposited on hairs of ruminants, rodents and horse, taken into mouth of host, where they hatch or in oesophagus, the resulting maggots making their way slowly through the tissues to a position beneath the skin where they provide an air-hole and develop rapidly. Hypoderma, Oedemagena and Oestromyia. One of the most remarkable, widely divergent and at the same time well known groups of the superfamily Muscoidea.

It is to be noted that the statements "dissected and drawn" and "dissected" refer always to the female reproductive and accessory organs; also that the term maggot as used refers always to the first-stage maggot only, unless otherwise specified. The term series above is not used in a strictly taxonomic sense. The maggots of most of the genera mentioned above for maggot characters have been drawn and described.

Although much has been already accomplished in the investigations above outlined, the results as tabulated most graphic-

ally illustrate the astonishing amount of such work that yet remains to be done. The above 37 series, as defined or at least mentioned, and including others indicated therewith, will no doubt be more than doubled before the work is brought to a satisfactory conclusion. I have at present in tentative outline some 91 groups—taxonomic categories which are to be considered of subfamily or tribal rank, perhaps better the latter, and which may be termed GROUP UNITS. But before these can be satisfactorily defined, hundreds of type species of genera must be carefully dissected and figured, as well for their eggs and maggots as for the reproductive system. It is now most confidently believed—in fact, it is axiomatically apparent—that this method of work will finally clear up the taxonomy of these flies and put it on a sound basis.

ADDENDA.

In order to bring the outline of results up to date of reading proof of the foregoing (April 15, 1911), I wish to add the following very brief particulars:

CALLIPHORINE series—Synthesiomyia belongs here, as shown by dissection of Peruvian material. It was formerly thought to be more closely allied with Musca.

MESEMBRININE series—Dr. Lutz has sent me three specimens in fluid of Pseudogametes for dissection, but unfortunately all are males. The fly has a wonderfully strong Oestrid habitus, greatly resembling Cuterebra in general form and appearance. It will almost certainly need a separate group, the Pseudogametine.

SARCOPHAGINE series—Sarcophaga auribarbata n. sp., aurigena n. sp., argenta n. sp. (all Peru) have been dissected and drawn. Sarcophagula peruana n. sp. (Peru) and many other species of several genera (Florida and Peru) have been dissected and the maggots drawn.

TD 354, from Massachusetts, which is apparently closely related to this group, if not a member of it, is remarkable as showing most clearly in the first-stage maggot the seven main pairs of sclerites of the cephalopharyngeal skeleton enumerated at the end of these addenda, with the single exception of the dorsopharyngeal sclerite which is rudimentary or nearly absent.

METOPIINE series—Prof. Osborn's important observations on the habits of Senotainia (Ohio Nat., VII, 1906, p. 38) indicate that these flies are guided to the nests of the host by observing the latter in the act of transporting spiders or caterpillars with which to provision same. I believe the maggots are deposited in choria, and stuck to the spiders or caterpillars. After the nest is closed the increased temperature probably arouses the maggots to activity, whereupon they first devour the egg or grub of host and then attack the stored provision. The entire contents of the uterus, which are not great, are deposited almost certainly at one time, extending over several hours, and probably may all be deposited in one nest if the conditions are favorable. Perhaps the fly attaches a maggot to the egg of host.

COMPSILURINE series—Eucelatoria australis n. sp. (Peru) has been dissected and drawn. The piercing larvipositor in this group is composed of two pieces, of which the upper is much shorter than the lower, the lower being concave dorsally and the upper concave ventrally. Both are sharply pointed but the lower piece curves broadly downward to the point and forms the main piercing organ. The two pieces are hinged at the posterior edge of their broad basal portion and the vagina opens between them. The maggot is expelled between these pieces within the skin of the host. Bouche, Heim and Kirschner were right as to the piercing function of this organ, while Giard was wrong. Nielson adopted the latter's view in his criticism of my original announcement of subcutaneous larviposition in these forms, to which I replied in Science (issue of Feby. 4, 1910, p. 195).

There are other forms with what appears to be a piercing larvipositor. Mention has already been made of TD 480, which seems to be near Alophora (see Phasiine series). Another case is furnished in a fly from Massachusetts with pseudodexiine aspect, TD 371, which has a broad blade-like larvipositor. These, if true piercers, are probably cases of independent specialization not indicating relationship with this group. Emphanopteryx (not Cryptomeigenia) has a piercer-like organ in the female, but it is doubtful if it is functional as piercing the skin of the host.

The genus Celatoria probably also possesses a piercing larvipositor similar to that of Compsilura. Judging wholly from the descriptions and figures, Coquillett evidently misinter-

preted the sexes. The sex which he calls the male and which has the strong ventral keel is apparently the female, the keel being functional as a protection to the point of the larvipositor. The ventral groove described indicates this, and the fifth segment mentioned is probably the broad basal part of the larvipositor. If my surmise is correct, it appears that this form is unique in having the male front wider than that of female. At all events the genus must go in a group by itself, the CELATORIINE, on the remarkable spinose character of the last-stage maggot and puparium combined with the other striking characters.

GYMNOSOMATINE series—Gymnosoma sp. (California and Veracruz) dissected, TD 1815, 1815a. The uterus was not noted and is probably absent. The egg is large, white, very elongate-oval, flattened, chorion without reticulation. Gymnosoma and allies, perhaps including Oedemasoma, Parasites of adult pentatomids. Habit, host-oviposition.

TACHININE series—Neilsen is evidently wrong in his statement that his Tachina larvarum deposited maggots. The eggs which he referred to Carcelia were almost certainly those of his T. larvarum. This can be seen by reading his text. In his second paper (1910) he shows the egg of Carcelia to be pediceled.

MEIGENIINE series—This will need further division. The present forms are parasites of Chrysomelid larvae, sawfly larvae, and lepidopterous larvae. Tachinomyia appears to belong here. The following further groups can be indicated at present.

VIVIANIINE series—For Viviania, Cryptomeigenia and allies. All are parasites of adult beetles so far as yet known.

THRIXIONINE series—Thrixion and allies. Parasites of adult phasmids, etc.

PLAGIOPINE series.—Plagiops littoralis gen. et sp. nov. (Ocean Beach, So. Florida), TD 738, mentioned above under Meigeniine series, dissected. The uterus was not noted but is perhaps present. The egg is small, flattened, and ovate. Habit, host-oviposition.

PLAGIINE ser—Siphoplagia sp. (Florida) dissected, TD 489; Cyrtophloeba sp. (Mass.), TD 2731, and Plagia sp. (Mass.) TD 2711, dissected. The uterus is in several coils and strap-like in upper extent, the elongate subcylindrical eggs packed in

rows and developing maggots therein. Habit, larviposition probably on host, as the uterine capacity is limited to a few hundreds.

ZYGOSTURMIINE series.—This is the 15th series above. Zygosturmia inca gen. et sp. nov. (Peru) dissected and drawn, TD 4031. Coquillett's Sturmia distincta and my protoparcis belong to this genus apparently. The oviducts are quite long and slender, common oviduct about two-thirds as long as oviduct, tubular glands about one and one-half times as long as common oviduct plus oviduct, spermathecal ducts about as long as common oviduct, tubular gland ducts only a little shorter than spermathecal ducts; ovaries with comparatively few ovarioles; no true preuterus; uterus strap-like, in but one or two coils, eggs and maggots packed in on the Echinomyiine plan.

AZYGOBOTHRIINE series—Azygobothria aurea gen. et sp. nov. (Peru) dissected and drawn. The ovaries are large, of many ovarioles. Common oviduct is about as long as one ovary. There is a nipple-like preuterus. The spermathecal ducts are very long, fully twice as long as common oviduct, sinuate, bent at or below middle. Tubular glands are short, only half as long as common oviduct, their ducts nearly twice as long as the glands. The uterus is wide and strap-like, in about two coils more or less.

Argyrophylax and Zygobothria seem to belong in the neighborhood of these two series, but may not come within either.

HYSTRICIINE series—The leaf-larvipositing forms will need division into at least seven groups, the present including Hystricia, Bombyliomyia, Jurinia and allies. The others follow:

MELANOPHRYONINE series—Melanophrys and Artopharista which may or may not be the same.

PANZERIINE series—Panzeria, Varichaeta and their allies. Nielson has described the first-stage maggot of Panzeria as having no minute colored plates, which I think is a mistake. The fragment which he thought to be first stage of this species seems either not to have been this species or else to have been a piece of a second-stage skin. His text and figures indicate this conclusion.

MICROPALPINE series—Micropalpus and allies. Copedrypta may or may not come here.

ECHINOMYIINE series—Echinomyia, Fabricia and allies. Peletria and their allies may come here.

SAUNDERSIINE series—Saundersia, Epalpus and their allies.

DEJEANIINE series—Dejeania, Paradejeania and Lasiopalpus.

MASICERATINE series—This and the 18th and 19th series above represent only a part of the leaf-ovipositing minute-egg forms of Tachinidae, which exhibit a surprising variety of type, in female reproductive organs and eggs. They may be divided as follows, so far as now known, leaving the present group for Masicera, Blepharipa and allies, which have a long uterus containing black eggs with a honey-comb reticulation of the chorion.

BRACHYMASICERATINE series—This is the 18th series above. Brachymasicera polita gen. et sp. nov. (Peru) dissected, TD 3987 Short uterus, black eggs, chorion with a wrinkle pattern and not honey-comb reticulate.

BELVOSIINE series—Belvosia, Latreillimyia and allies. Belvosia piurana sp. nov. (Peru) dissected, TD 4032. Uterus long, eggs black, chorion without reticulation but coarsely punctulate, the punctures largely double and triple.

Triachora has the chorion more finely and evenly punctulate, the punctures all single.

BLEPHARIPEZINE series—Blepharipeza, Parachaeta and allies. Long uterus with black eggs, the chorion conspicuously honey-comb reticulate, the divisions with minute raised points.

GONIINE series—Many specimens of various spp. of Gonia from both North and South America have been dissected, and drawings made of two of the dissections which appear widely different. One is a short thick uterus in only one to two coils, with very short oviducts and large ovaries, TD 4011; the other is a very long uterus in five or more coils, with elongate oviducts and somewhat smaller ovaries, TD 4037. Both are from Peru. Other specimens from Piura, Nana (near Lima), and Arequipa, Peru, show both long and short uteri, and I have found developed maggots in the short uterus as well as in the long one. The eggs are minute, flattened ventrally, ovate to subcircular; the chorion is without reticulation, but evenly, closely and very finely punctulate throughout. Preuterus present, common oviduct short, spermathecal ducts and tubular glands elongate. The maggot is elongate-pyriform, sometimes appearing nearly sub-

cylindrical, and appears to lie curled in the sub-circular or oval egg. Pressure on the egg often causes it to assume an elongate narrow form pointed at ends, inside which the maggot probably lies straight. Slight pressure or teasing with a needle causes the cylindrical anterior portion of the maggot to protrude from the ventral edge of egg, at right angle to long axis. I can see no difference in the maggots from the short and long uteri, and am constrained to believe that here the uterus gradually increases in length as the eggs descend from the ovaries and fill it, although oviposition may begin while the uterus is still short. If this is so, it is an exceptional case in the great increase of length after maggots have become fully formed within the choria. There seem to be two forms of the flies in the Peruvian material, distinguishable externally, but the separation does not accord with the uterine difference. One or both of these forms are probably what has been called Gonia chilensis.

My dissections have shown Gonia frontosa (Mass.) to have a long coiled uterus; and what I identify as G. pallens and G. angusta (S. Florida) to have a very long uterus. The chorion of the egg is the same in these forms as above described.

The above observations indicate that much care and judgment must be used in describing the female reproductive organs in these flies. I have noted variations in lengths of uterus in other forms within certain limits; and variation in the number of rows of eggs in the strap-like forms of uterus as well as in certain others, without a corresponding variation in length. It is evident that we need careful investigations in various groups which shall determine how many days elapse between issuance of the fly or fertilization and complete development of the female reproductive organs. I have noted that in Varichaeta, under artificial conditions, this takes about fourteen days.

PHASIATACTINE series—Phasiatacta elongata gen. et sp. nov. (Peru) dissected and drawn, TD 4019. Uterus extremely long and slender, in very many coils and irregular turns, preuterus present. Ovaries large, oviducts long and slender, spermathecal ducts long and curved, tubular glands elongate. Eggs black, elongate, pointed at each end, chorion with areoles gathered around a dorsal opaque area, without reticulation.

CNEPHALOMYIINE series—Cnephalomyia floridana gen. et sp. nov. (So. Fla.) dissected, TD 877. Uterus very long and

slender, eggs blackish, elongate, obtusely pointed at each end, chorion, with an almost perfect hexagonal reticulation, interspersed with fine punctulations.

Cnephalodes pollinosus gen. et sp. nov. (Peru), TD 4038, which has been dissected and drawn, probably belongs here. The uterus is extremely long and slender, in numerous irregular coils and turns, the eggs elongate in single to quadruple file, chorion black with honeycomb reticulation and punctures. The characters of the maggot, including those of the cephalopharyngeal skeleton, show a close relationship with Gonia.

OPHIROSTURMIINE series—This is the 19th series above. Uterus long and in many coils, eggs brownish-yellow, chorion honey-comb reticulate interspersed with closely-set microscopic raised points. Oviducts long, spermathecal ducts very long and slender, tubular glands moderately long, preuterus present. Phasmophaga evidentally does not belong here.

OMMASICERATINE series. Ommasicera chaetosa gen, et sp. nov. (Peru) dissected and drawn, TD 4018. Uterus short and thick, in only one and a half or two coils; eggs brownish-yellow, chorion with an elongate-hexagon reticulation like a honeycomb pattern drawn out of shape longitudinally.

This concludes the leaf-ovipositing groups so far as I am able at present to indicate them. But there remains a multitude of these forms yet to be assigned, among which I can give notes on the following:

Paragermaria has a very long slender uterus, about 40 mm. in length, eggs black, chorion without reticulation, finely punctulate much like that of Triachora. It probably goes in the GERMARIINE series, which will include Germaria and allies.

Cnephalia has a very long and slender uterus containing black eggs.

Attacta, as represented by a specimen from Guatemala which I doubtfully refer to this genus, has black eggs whose chorion is not honey-comb reticulate but shows minute punctures in a roughened surface. The uterus is probably elongate. The puncture pattern of the chorion appears in the peripheral area like a chitinous network, with an elongate or oval less-closely punctured central area. The surface of the chorion is closely and minutely roughened with projecting points.

Ceromasia has brownish-yellow eggs, the chorion is intensely honey-comb reticulate, each division closely set with microscopic raised points.

Phasmophaga has a brownish-yellow egg, the chorion appears not to possess any reticulation and is not punctulate; the surface appears to be quite smooth.

TD 390 (Mass.) is a small fly with a disproportionately long uterus; it has much the habitus of Eusisyropa, and has been determined by Mr. W. R. Thompson as Masicera sp. near pauciseta. The egg is deeply yellow with a slight brownish tinge, the chorion is reticulate with nearly perfect hexagons, and the surface is sparsely set with long chitinous spine-like points which look like short hairs growing therefrom. No punctulation.

TD 355 (Mass.) was at first determined by me as Eusisyropa blanda and so published in Tech. ser. Bull. 12 Bur. Ent., p. 116. I doubt if it is that genus. It contained some 700 whitish eggs in the uterus, which was thus probably of the short thick type. These eggs show the nearly mature maggots within. The chorion is thin, without reticulation or punctulation, and has much the appearance of the Phasmophaga chorion externally.

Finally, TD 747, a small yellow-legged fly with a pseudodexiine habitus and a very long slender uterus, from Ocean Beach, South Florida, shows black eggs whose chorion appears very similar to that of Phasmophaga in structure. There is no punctulation or reticulation, and practically no appearance of rugosity, the surface being quite smooth. Filaments of translucent substance appear to depend from the ventral surface of this egg, showing in every one of many mounted specimens as pendulous loops and coils. I have seen nothing of the kind in any other egg. They are perhaps intended for more secure attachment to leaf surfaces.

These examples might be multiplied, but I have given sufficient to show the wonderful diversity of type exhibited by these minute-egg forms, all of which are believed to oviposit upon the foliage of the plants.

OPHIRIONINE series—This name should be applied to the 21st series above.

EUMYOBIINE series—Eumyobia flava gen. et sp. nov. (Peru) dissected and drawn, TD 4021. Ovaries large, oviducts short, common oviduct long, spermathecal ducts and tubular glands short, preuterus present; uterus very heavy and thick, in two stout coils or so, the elongate maggots developing therein. The eggs and maggots are packed in irregularly, in various posi-

tions. Pyrrhosia may belong here, and the present form may be that genus or one of its near allies, being apparently what Coquillett determines as Leskia. I have no alternative, however, but to name it to prevent doubt hereafter.

PSEUDODEXIINE series—There are almost certainly many distinct groups here. The ORPHIRODEXIINE series must be erected for Ophirodexia and its allies.

ATROPHOPODINE series—This is quite distinct from Ophirodexia, as shown by Diaphoropeza peruana sp. nov. (Peru) dissected and drawn, TD 4026. This species is not typical of the genus but comes nearer to it than to any other, and certainly belongs to the Atrophopoda group. Ovaries not large, oviducts very short, common oviduct very long, spermathecal ducts and tubular glands short, preuterus present; uterus thick and swollen, in one coil or so, eggs and maggots very oblique to ongitudinal. It is as yet doubtful if Vanderwulpia can be here included. The group is proposed for Atrophopoda and its allies.

BESKIINE series.—Beskia and allies. No proper material for dissection has yet been available but the group must be pointed out as probably furnishing a most marked deviation in larval habit from any hitherto known in the muscoid flies. In 1908, Mr. E. O. G. Kelley found, at Pawnee, Oklahoma, a maggot which he observed at the time to be, to quote from Mr. Webster's letter on the subject, "in the act of actually feeding on a grain aphid of wheat, probably Macrosiphum granaria." This maggot changed to a puparium which was attached to the base of a wheat leaf. From this puparium issued a fly of Ocypterosipho aelops, which is very close to Beskia if not the same. No confirmation of this larval habit has come to light since, but although the record is a most surprising one it is probable that the maggots of these flies are external feeders on aphids and perhaps some other soft-bodied insects. The anal stigmata of the puparium are borne at the ends of long processes which suggests an analogy with aphidophagous syrphids.

STEINIELLINE series—From what Nielsen has shown of the characters of the first-stage maggot of Steiniella, the genus represents a separate group. This maggot possesses minute colored subchitinized plates interspersed with short spines, some of the plates bearing spines on their posterior edge. The maggots are almost certainly not deposited on leaves. The form is not

allied with the Hystriciine group of series, the adult being very distinct in external characters. The minute colored plates of the first stage maggot are evidently an independent specialization, and are interesting as indicating the probable method of development of the more perfect colored scale-like plates of the leaf-larvipositing forms.

PSEUDOMYOTHYRIINE series—This is the 27th series above. Pseudomothryia perplexa sp. nov. (Peru) dissected and drawn, TD 4001, 4035. Ovaries small, of only about six ovarioles. Oviducts about one-third as long as ovary, common oviduct about twice as long as oviduct, spermathecal ducts very elongate, tubular glands about the length of latter, preuterus absent. Uterus slender, laterally compressed, in three to four coils, inside each other disposed in a more or less regular spiral, eggs and maggots in single file. The oral spine which terminates the mandibular sclerite of the cephalopharyngeal skeleton in the first stage maggot is very sharp and needle like. Methypostena and Tachinophyto perhaps come here. It is quite likely that Erynnia nitida, the European tachinid parasite of the imported elm-leaf beetle, occurs in North America and had been determined by Coquillett as Hypostena barbata.

EUZENILLIINE series—Euzenillia aurea gen. et sp. nov. (Mass.) dissected, TD 350. In this dissection the reproductive organs were not extracted intact, and I can judge only from the maggot which is a wholly new type. The latter is elongate, moderately slender, and thickly clothed all over with short fine minute spines except on posterior half of dorsum. The cephalopharyngeal skeleton is rather slender. The spermathecae are suboval or elongate-rounded, and the larvipositor is normal. A uterus is present, which is probably not long.

PAREXORISTINE series—Carcelia belongs here. Nielson, in his second paper (1910), has shown the egg to be elongate and pediceled, as in Parexorista.

DEXIINE series—This series needs splitting into several groups. Aside from the typical group, to include Dexia and allies, the following may be given as at present recognizable:

ALMUGMYIINE series—For Almugmyia and allies, whose reproductive characters are mentioned under the Dexiine series above. Microchaetina probably comes here, and may prove to be the same as the present form.

SIROSTOMINE series—This will include Sirostoma and its allies, which are white-grub parasites. The females deposit their maggots at the surface of the soil, into which the latter penetrate in search of hosts. Phorostoma probably comes here.

SARDIOCERATINE series—Sardiocera and allies. Theresia and Eutheresia gen. nov. for Coquillett's Theresia analis, probably come here. All are parasites of wood-boring grubs of Coleoptera. The host relations of Eutheresia are most interesting, and will be detailed elsewhere. The maggots of Sardiocera (which I determine as Coquillett's Theresia tandrec) and Eutheresia both have a pair of short anal processes carrying the tracheas with the anal stigmata at their ends.

PROSENINE series—For Prosena, Myiocera and allies.

ECHINODEXIINE series—For Echinodexia and allies. Probably Hystrichodexia, Eudexia, Hystrisiphona, and Bathydexia come here. These forms are distingiushed in the fly by having spine-like macrochaetae on scutellum and abdomen, and would thus seem to form a natural group by themselves. This character probably does not carry with it the leaf-larviposition habit, although the flies bear a strong superficial resemblance to the Hystriciine and allied forms. It will be noted that spine-like macrochaetae occur in the Blepharipezine series of the leaf-ovipositing minute-egg forms; also that this character does not extend to all the leaf-larvipositing forms.

MYIOPHASIINE series—The females of Ennyomma globosa, parasitic in Chalcodermus aeneus in cowpea pods, probably deposit the living maggots at the weevil punctures of a certain age, and the very slender maggot bores in next the periphery of the hardened-sap pellicle which closes the puncture until it reaches the semiliquid frass, through which it can easily gain access to the host grub.

PHASIOPTERYGINE series—The peruvian species mentioned above, TD 4005, is Phasiopteryx australis sp. nov. It has been dissected and drawn. The uterus is about sixty millimeters in length, from one-sixth to one-half millimeter in width, and is perhaps the extreme development for relative length and slenderness in the superfamily, though Phasiotacta is a close second.

On page 78, T. A. E. S., XIII (March, 1895), I mentioned two specimens of a fly from Doctor Forbes, Ills., as doubtfully referable to Ormia, one of which was reared from Crambus sp. If these specimens belong to the Oestrophasiine series, as is quite

probable, this will form the only rearing record yet known of any immediate relative of this group. Here seems to be a hint explanatory of the remarkable specialization of the first-stage maggot in Phasiopteryx, for it is probable that Oestrophasia has a similar maggot. The larvae of Crambus work underground, in silk-lined galleries, feeding on the stems of growing plants, especially corn. The Phasiopteryx type of maggot would be quite well adapted to search out such hosts. Its smooth segmental plates would enable it to penetrate the silken walls of the galleries, where an ordinary maggot would become enmeshed. Yet one cannot help thinking that the Phasiopteryx maggot is rather needlessly specialized for such prosaic purpose. Perhaps Oestrophasia has a still different type of maggot.

Characterizations to fit the new generic and specific names used in this article will be shortly published, probably in the more exhaustive paper from which the whole of the present data are taken in advance. I must explain that I consider it quite obligatory upon me, in all cases of doubt as to the determination, to give new names generic and specific to the forms dissected, described and figured. These names will fix the forms so as to prevent any further doubt arising as to their identity. If this plan increase the synonymy, as it doubtless will to an extent, there is no positive harm done; while the positive good is secured of certainty in determination.

In the forthcoming more complete paper will also be given fuller explanations of the functions of the various parts of the female reproductive system; the necessity for the use of the terms preuterus, uterovagina, etc., which may be thought by some to be superfluous, with numerous plates illustrating all the reproductive types that have been drawn.

I wish to announce that, after an extended comparative study of many maggot types, I find the first-stage cephalopharyngeal skeleton to consist of seven original main sclerites, all paired, as follows:

1. PHARYNGEAL—"lateral pharyngeal" of Hewitt in whole or part; "upper pharyngeal" of Nielsen plus "lower pharyngeal" of same author in whole or part.
2. INFRAPHARYNGEAL—lower wing of "lateral pharyngeal" of Hewitt in part; "lower pharyngeal" of Nielson in part.
3. DORSOPHARYNGEAL—"dorsal pharyngeal" of Hewitt.
4. HYPOSTOMAL—after Hewitt.
5. INFRAHYPOSTOMAL—"the plate below the skeleton "of Nielsen.
6. MANDIBULAR—after Hewitt.
7. DENTATE—after Hewitt.

A considerable number of minor sclerites occur in various forms, but all seem to be derived from the above seven main ones, except those of the oral region which belong to the pseudocephalon and are probably developed from it. I have an extensive series of drawings of a very large number of types of first-stage skeleton, which will be published in due time in connection with a comparative study of all the sclerites that go to make up the skeleton in the various forms.

Under the Sarcophagine series in these addenda is mentioned TD 354 from Massachusetts, which most clearly shows all the above main sclerites except the dorsopharyngeal. The infrapharyngeal is so clearly exhibited in this form as to prove beyond doubt, I think, its distinctness as one of the main sclerites. In most forms the infrapharyngeal, while more or less present, is so intimately connected or welded with the pharyngeal as to appear a part of the latter. This has misled Nielsen and others.

It is worth while mentioning in a speculative way that the above seven main pairs of sclerites may represent the seven embryonic segments absent in the muscoid maggot, which have been inverted to form the skeleton proper of the maggot mouth and pharynx. The head in the most primitive insects is believed to be composed of seven segments and the abdomen of ten, the three thoracic segments bringing the total number to twenty. There are twelve segments in the muscoid maggot besides the pseudocephalon. Dr. C. Gordon Hewitt's admirable monograph of Musca may be studied with much profit in this connection.

What I have heretofore called the clypeus in the fly (Taxonomy, pp. 22-24) seems to be a part of the everted dorsal wall of the pharynx chitinized. The true clypeus is apparently the lower portion of what I have called the facial plate. The labrum seems to have projected itself forward, carrying with it the epipharnyx to form the dorsal part of the haustellum, and in this way becoming widely separated from the clypeus. Into the space thus left there appears to have been everted the chitinous portion of the pharynx to form the rostrum of the proboscis, which attaches basally in front to the epistoma or anterior edge of the clypeus, The morphological sequence of the parts is thus lost when the proboscis is extended, but when the latter is retracted the rostrum is inverted to a semblance of its original morphological position.

It should be stated that the ultimate categories of genera, or those which will eventually be found most serviceable for taxonomic recognition and which I shall call GROUP UNITS, may be considered as generally equivalent to tribes in other groups of insects. Most of the series given in these addenda are to be considered as such, and for that reason I have given them the names of the genera dissected and studied.

The article by me in a recent issue of "Science" entitled "On muscoid and especially tachinid synonymy, may be profitably read in connection with this preliminary outline of results to date in the Muscoidea.

ROBBERFLIES OF THE GENERA PROMACHUS AND PROCTACANTHUS.

JAMES S. HINE.

The species of these two genera from America north of Mexico, have been considered by Williston in Volume XII, of the Transactions of the American Entomological Society, and the Mexican species of Promachus have been tabulated by Osten Sacken in Biologia, Diptera I, 192. The fact that it has been possible to get together an extensive collection of specimens of various species from different parts of North America has led me to make an attempt to identify many of the Nearctic forms, and as some success at least has been attained the following results are offered for the consideration of those, who for any reasons, have interest in the various species included.

One can not study these flies in the field without noting their highly predaceous habits. These habits have attracted the attention of observers in the past with the result that a few of the species have been mentioned as injurious from the standpoint of killing honey-bees and other useful insects, but in most cases the feeding habits are variable to the extent that each species accepts a large variety of insect life as food, so that after all it seldom happens that their attacks are concentrated in a particular direction sufficiently to establish a marked habit which shall be considered either injurious or beneficial. They are among the largest species of their subfamily, some specimens measuring nearly forty-five millimeters in length and the smallest over twenty millimeters, so if their predaceous habits could be controlled the results, very likely, would be of extraordinary importance.

The material used in the preparation of this paper has been procured from various sources and I am under many obligations for favors. The United States National Museum and the museums of Cornell University and the University of Kansas each have loaned specimens for study. Professor J. R. Watson, of Albuquerque, New Mexico, has sent me several specimens from that interesting region; Professor J. H. Schaffner has donated the material he collected during two summers in central Kansas; Professor C. F. Baker has sent me much material that D. L. Crawford collected in Mexico during the season of 1910; while Charles Dury of Cincinnati, and H. S. Harbeck, of Philadelphia, and others have forwarded various species from

their respective localities. D. W. Coquillett, Chas. W. Johnson, J. M. Aldrich and other Dipterologists have aided in various ways. One finds it much pleasanter to work at a difficult task when he meets with such encouragement as I have had in this study.

The characters available for the separation of the species in both of these genera are rather meager and I doubt not that students will experience more or less difficulty in using the keys and descriptions. The differences which distinguish species are sufficiently evident, however, for the purpose when the proper comparisons can be made, but without the opportunity to make comparisons as is the case when a single species is considered one may not always feel satisfied with results.

I was not able to get all of the described species from Mexico and Central America but where I possessed specimens of species from these countries they are included in the consideration of their respective genera.

A list of the species and synonymy is given below but the reader is referred to Aldrich's Catalogue of North American Diptera and to other works for further references to literature.

LIST OF THE SPECIES OF PROCTACANTHUS.

arno Townsend, Proc. Cal. Acad. Sci. IV, 599.
brevipennis Wiedemann, Auss. zw., I, 431. Van der Wulp, Tijdsch. v. Ent., XXV, 108. Williston, Trans. Amer. Ent. Soc. XII, 73.
caudatus new species.
coquillettii new species.
duryi new species.
fulviventris Macquart, Dipt. Exot., Suppl. IV, 88. Osten Sacken, Catalogue 235, note.
heros Wiedemann, Auss. zw., I, 427. Schiner, Verh. Zool. Bot. Ges., 1866, 682; 1867, 396. Williston, Trans. Amer. Ent. Soc., XII, 74.
longus Wiedemann, Dipt. Exot., 183; Auss. zw., I, 426. Macquart, Hist. Natur. Dipt., I, 307; Dipt. Exot., I, 2, 123. Schiner, Verh. Zool. Bot. Ges., 1866, 682; 1867, 396.
craverii Bellardi, Saggio, II, 50. Williston, Biologia, Dipt., I, 327.
micans Schiner, Verh. Zool. Bot. Ges., 1867, 397.
milbertii Macquart, Dipt. Exot., I, 2, 124.
missouriensis Riley, 2d Mo. Report, 122, fig. 89.
?agrion Jäennicke, Neue Exot. Dipt., 57.
nigriventris Macquart, Dipt. Exot., I, 2, 124.
nigrofemoratus new species.
occidentalis new species.
philadelphicus Macquart, Dipt. Exot., I, 2, 123. Williston, Trans. Am. Ent. Soc., XII, 75.
rufiventris Macquart, Dipt. Exot., I, 2, 123, plate X, figure 2.
rufus Williston, Trans. Am. Ent. Soc., XII, 74.

Of the other North American species that have been placed in Proctacanthus, exquisitus Osten Sacken must belong to the genus Asilus if one may judge from the figure, for the posterior branch of the third vein meets the margin of the wing distinctly behind its apex; P. virginianus Van der Wulp has the appearance of a species of Erax. The specimen figured is a female and no spines are shown at the tip of the ovipositor; this fact, together with the presence of a stump of a vein at the base of the anterior branch of the third longitudinal suggests Erax, for I have never found a species of Proctacanthus with this character present; Proctacanthus zamon Townsend has been known as a synonym of Eccritosia amphinome Walker for some time.

List of the Species of Promachus.

albifacies Williston, Trans. Am. Ent. Soc., XII, 63. Osten Sacken, Biologia, Diptera, I, 195.

bastardii Macquart, Dipt. Exot., I, 2, 104.
laevinus Walker, List II, 108.
rubiginis Walker, Dipt. Saund., 123.
ultimus Walker, Dipt. Saund., 136.
philadelphicus Schiner, Verh. Zool. Bot. Ges., 1867, 389.

fitchii Osten Sacken, Catalogue, note 121, 234.
apivora Fitch, Country Gentleman, XXIV, 63; 3d N. Y. Report, 251, plate IV, figure 7.

forfex Osten Sacken, Biologia, Diptera, I, 194.
quadratus Bellardi, Saggio, II, 27, plate II, figure 3.

giganteus new species.

minusculus new species.

nigrans new species.

nigripes new species.

princeps Williston, Trans. Am. Ent. Soc., XII, 62.

quadratus Wiedemann, Dipt. Exot., 201; Auss. zw., I, 485. Osten Sacken, Biologia, Dipt., I, 192.

rufipes Fabricius, Syst. Ant., 794; Syst. Antl., 169. Wiedemann, Dipt. Exot., 203; Auss. zw. I, 487. Williston, Trans. Am. Ent. Soc., XII, 107.

sackeni new species.

truquii Bellardi, Saggio II, 80, plate II, figure 6. Williston, Biologia, Dipt., I, 322.

vertebratus Say, Journ. Acad. Sci. Phil., III, 47; Compl. Works, II, 62. Williston, Trans. Am. Ent. Soc. XII, 62.

Five species of Promachus from Mexico and Central America could not be procured so they are not considreed in this paper. They are anceps Osten Sacken, cinctus Bellardi, magnus Bellardi, nobilis Osten Sacken and pulchellus Bellardi.

Promachus fuscipennis, according to Osten Sacken, is not a North American species and Promachus trapezoidalis Bellardi is rightly included in the genus Mallophora as Williston has stated for it has the claws distinctly blunt at the tips. It may be of interest to state that this latter species has been taken at Brownsville, Texas. Heretofore it was known only from Mexico.

THE GENUS PROCTACANTHUS.

Proctacanthus was described by Macquart in 1838. The species falling here are all rather large and robust, the marginal cell is closed, palpi one segmented, antennal bristle bare, veins closing the discal and fourth posterior cells not parallel, the posterior branch of the third vein curves forward to meet the costa before the tip of the wing, anterior branch of the third vein not angulated at base nor does it bear a stump, ovipositor cylindrical and with a terminal circlet of spines which may be very small in some species, abdomen longer than the wings. These characters are all well marked and there is no difficulty in placing the various species in the genus. The venation is much like Erax but the circlet of spines at the tip of the ovipositor and the lack of silver white segments at the posterior part of the male abdomen are distinctive.

KEY TO THE SPECIES OF PROCTACANTHUS.

1. Segments of the abdomen thickly pilose on the sides, very large red species. **heros**
   Abdomen pollinose or sparsely hairy, smaller species.....2
2. Femora black, tibiae red, the colors strongly contrasting.....3
   Femora and tibia of nearly the same color, so there is no strong contrast in colors.....4
3. From above the hypopygium is wide, and longer than segments seven and eight combined. Male abdomen largely red, female abdomen not red. **caudatus**
   Hypopygium small, distinctly shorter than segments seven and eight combined. Abdomen of both sexes largely red above.....**fulviventris**
4. Abdomen red, except the first segment and anterior border of the second....5
   Abdomen in large part gray pollinose.....6
5. Dorsum of the thorax uniformly brown, hypopygium from above wide, appendages longer than segments seven and eight combined.....**rufus**
   Dorsum of the thorax usually striped with black, hypopygium small, the appendages from above shorter than segments seven and eight combined.....**rufiventris**
6. End lamella of the ovipositor densely pilose, spines at the tip small 7
   End lamella of the ovipositor sparsely hairy and with a circlet of enlarged spines at the tip.....8
7. Wings nearly hyaline, many of the veins faintly margined with brownish.... **occidentalis**
   Rather small species, middle of the wing with a large dark colored patch **coquillettii**
8. Wings hyaline or with only the veins margined with brown.....9
   Wings of a uniform brown all over.....12

9. Scutellum with white bristles.....**duryi**
Scutellum with black bristles.....10
10. Wings clear hyaline, all the femora entirely black.....**nigrofemoratus**
Wings with the veins margined with brown, at least the posterior sides of all, the femora red.....11
11. Male genitalia elongate, the appendages curved inward at the tips and enclosing an open space beyond the other parts.....**arno**
Male genitalia short, appendages but slightly longer than the other parts **micans**
12. Thorax with brown markings, wings clear brown.....13
Thorax with dark, nearly black, markings, wings pale brown.....14
13. Wings long and wide, palpi with white hair, two or three bristles on the front side of the hind femora besides those near the apex.....**longus**
Wings rather short and narrow, palpi with black hair, four or five bristles on the front side of the hind tibia besides those near the apex **philadelphicus**
14. Abdomen very dark, nearly black pollinose.....**nigriventris**
Abdomen lighter, gray pollinose.....15
15. Large stout species, middorsal stripe of the thorax gray pollinose and not plainly differentiated.....**milbertii**
Small, rather slender species of southern distribution, middorsal thoracic stripe usually plainly differentiated and not distinctly pollinose.....**brevipennis**

Proctacanthus heros Wiedemann.

Total length, 32 to 45 millimeters. Body red all over, mystax and beard straw yellow, occipito-orbital bristles straw yellow; legs red with black bristles and yellow hair; bristles of the scutellum black; wings brown, some of the cells along the inner margin nearly hyaline at the middle. First four or five abdominal segments on each side with an area of dense yellow pile, hairs on the dorsum of these segments and on all parts of the posterior segments short and black.

The large size of this species together with the red color of the entire body and the pilose areas on the sides of the abdomen easily characterize it.

Specimens from Southern Pines, North Carolina, collected by A. H. Manee. Also others from Georgia and Mississippi.

Other writers have reported it from Florida, South Carolina and Kentucky.

Proctacanthus rufus Williston.

Total length 30 to 36 millimeters. Body red, with the exception of the first abdominal segment and the anterior margin of the second which are black. Mystax and beard yellow, the latter lighter than the former, palpi red with pale hair; thorax and legs mostly with dark hair and bristles, scutellum with numerous black bristles, wings nearly uniformly pale brownish, dorsum of the thorax plain red without distinct markings of any kind. Abdomen black at base above, otherwise red, the former color extends back to the anterior third of the second segment. Male genitalia enlarged, wider than the last abdominal segment, appendages from dorsal view wide at the base and narrowed towards the apex.

The red legs, uniform red thorax and enlarged hypopygium are characteristic.

Specimens are at hand from Ohio, Arkansas, Kentucky, New Mexico and Massachusetts. Others record it from North Carolina and New Jersey in addition.

The species appears to be partial to bare sandy areas such as are present along lakes, seas and rivers and in semi-arid regions. The larval and pupal stages are passed beneath the surface of the ground, and the pupa case is left partially protruding when the adult issues.

Proctacanthus rufiventris Macquart.

Total length 30 to 35 millimeters. This species is very much like rufus in coloration. In fact the only noticeable difference between the two is to be found in the markings of the thorax and the male genitalia. In most specimens of rufiventris the thorax is marked with dark, nearly black stripes and spots. The hypopygium is small, narrower than the last abdominal segment and the appendages from dorsal view are narrow for their entire length, short and rounded at the tips.

Specimens at hand from Louisiana, North Carolina, and Texas. Others record it from San Domingo, Honduras, and Porto Rico.

Proctacanthus fulviventris Macquart.

Total length 25 to 30 millimeters. Mystax and beard bright yellow, palpi black with yellow hair, proboscis and antennae black. Thorax black, scutellum with numerous yellow bristles and hairs; wings pale brown, femora clear black, tibiae red, except the apex of each which may be black, tarsi black or in some specimens the hind metatarsi are red. Abdomen black at the base, partly red posteriorly. Different individuals are colored differently. In two specimens before me the female abdomen is clear black except the dorsum of segments three to seven inclusive which is red, while in the male the segments beyond four are red, as is the dorsum of three and four, while the venter of the first four segments and the dorsum of the first two are practically all black. Male genitalia small, appendages much shorter than the last two abdominal segments, each widest at the base and gradually narrowed towards the apex which is rounded.

The small male genitalia together with the clear black femora and red tibia characterize the species.

The specimens before me are from Florida and records do not show that it has been collected in any other locality.

Proctacanthus caudatus n. sp.

Total length 28 to 30 millimeters. Mystax and beard pale yellow, palpi yellowish red with pale yellow hair, antennae and proboscis black; thorax dark with some light pollinose markings, bristles of thorax black, numerous but not very stout black bristles on the scutellum; femora black, tibia red, black at the apices, tarsi black; wings pale brownish. Male abdomen yellow, except first segment and the base of the second which are largely black, hypopygium from dorsal view wide, from side view widened near the apex which is obliquely truncate. Female abdomen entirely dark, except the posterior margin of each of the second to fifth segments which are red; first abdominal segment in both sexes with numerous yellow hairs on each side.

The male type and one female from Veracruz, Mexico, collected by D. L. Crawford, of Pomona College, Ontario, Cal.

The male hypopygium is very different from that of fulviventris or rufus.

In Volume I, page 206, Biol. Cent. Am. Osten Sacken mentions a female of a species of Proctacanthus which appears to be the same as this one. His specimen was taken at San Geronimo, Guatemala.

Proctacanthus occidentalis n. sp.

Total length 30 to 36 millimeters. A modest colored species having nearly clear wings with many of the veins narrowly margined with brown. Mystax very pale yellow, usually with a few black bristles, beard white, palpi black with some black and some white hair, occipito-orbital bristles partially white and partially black; thorax pale brownish or gray, mostly with black bristles, scutellum with numerous black bristles and scattering fine white hairs, humeral callus distinctly lighter gray than the other parts of the thorax and toward the median line from each of these is a small white spot which is of some use in determination for most other species do not have such a marking. Wings nearly hyaline, in most specimens the longitudinal veins are faintly margined with brown; femora red posteriorly and nearly black anteriorly, tibiae colored with reddish and blackish in various combinations; abdomen dark, gray pollinose, male genitalia shorter than the last two abdominal segments, appendages curved towards each other at the tips so that they nearly meet; female genitalia with the end piece densely yellowish pilose and with the spines at the tip so small that they are not plainly differentiated from the other hairs of the region.

Male type from Los Angeles County, California, and eleven other specimens from California and Idaho, mostly collected by Coquillett and Aldrich.

Proctacanthus coquillettii n. sp.

Total length 25 to 27 millimeters. Mystax and beard white or very pale yellowish, palpi black with white hair, antennae dark, nearly black, third segment short, oval, arista nearly three times as long as the segment which bears it. Thorax dark, brownish gray pollinose and with black and gray hair; legs with black and gray bristles and gray hair; femora uniformly dark, nearly black, tibiae and tarsi brownish red; wing hyaline with the middle third quite distinctly brown, abdomen uniformly dark, gray pollinose and with numerous gray hairs. Male genitalia rather short, appendages and other parts margined with dense rows of gray hair. Female genitalia with the end piece densely pilose but devoid of a terminal circlet of enlarged spines.

It is easily known by the brown patch on the middle of each wing, by the short third antennal segment and by the genitalia of the male. The female genitalia agree rather closely with occidentalis but differs from all other species by the spines at the tip being small and not plainly differentiated from others of the last segment of the ovipositor.

The female type and a male from Los Angeles, California, collected by coquillett, for whom I am pleased to name the species.

Proctacanthus micans Schiner.

Total length 26 to 36 millimeters. Mystax pale yellow, beard white, palpi black with most of the hairs with which they are clothed white, although there may be a few black ones. Occipito-orbital bristles mostly pale but in some specimens there are plenty of black ones. Thorax brown in ground color, grayish brown pollinose and with the usual dorsal markings, numerous black bristles on the posterior part with some gray hairs intermixed, anterior part with short black hairs; wings nearly hyaline with the veins quite distinctly margined with brown; legs rather dark from general view, femora dark before, brown behind, tibiae and tarsi in large part brown but somewhat variable. Abdomen dark, grayish brown pollinose; male genitalia rather small and compact, appendages scarcely protruding beyond the other parts, of nearly the same width throughout from side view and clothed with fine white hair. Female genitalia black or brown, end piece sparsely hairy and with a distinct circlet of strong spines at the tip.

The small compact male genitalia and hyaline wings with brown margined veins are characteristic.

Numerous specimens from Colorado, Arizona and New Mexico.

Proctacanthus duryi n. sp.

Total length 26 to 28 millimeters. Mystax pale yellow, beard and hair of the palpi nearly white, in fact all the bristles and hairs of the head are white or very pale yellowish. Whole body yellowish gray

pollinose, dorsum of the mesothorax and scutellum with pale bristles; wing clear hyaline, veins pale brown; legs rather light colored, femora darker before than behind, all parts of the legs with black bristles and pale hair. Hair and bristles of all parts of the abdomen gray. Male genitalia about as long as the last two abdominal segments, female genitalia with a circlet of strong spines at the tip.

The rather small size of the species, with the white bristles of the whole body, especially the scutellum, and the general pale color are distinctive.

Male type and numerous other specimens taken along the Ohio River in Ohio and Kentucky by Charles Dury for whom the species is named.

Proctacanthus arno Townsend.

Total length 28 to 36 millimeters. Mystax white, usually with a few black bristles beneath, beard white, palpi black with black and white hairs, proboscis black, occipito-orbital bristles partly black and partly white, whole body grayish brown pollinose. Thorax with the usual markings above, mesothorax above with short black hairs anteriorly and rather stout black bristles posteriorly, scutellum with many black bristles and a few white hairs anteriorly. Legs in general color rather dark, femora nearly black before, brown behind, tibiae and tarsi somewhat variable but often quite dark so that they show no contrast with the femora; wings hyaline, usually with the veins faintly margined with brown, but in teneral specimens they are entirely glassy clear. Abdomen rather slender, male genitalia elongate, longer than the last two abdominal segments, appendages from side view, narrowest at the middle, slightly widened and curved inward at the tips so that from dorsal view a distinct open space is enclosed beyond the other genital parts. Female genitalia usually shining black with short white hairs, end piece rather sparsely hairy with a circlet of strong black spines at the tip.

The long male genitalia as described characterizes this species fully.

The type was collected at the southern end of Lower California. Specimens are at hand from southern Arizona, New Mexico, Utah, Palo Alto, California, and El Paso, Texas.

Proctacanthus nigrofemoratus n. sp.

Total length of the male type 30 millimeters, other specimens vary from 23 to 30 millimeters. Mystax beard and hair of the palpi white; palpi, antennae and proboscis black; occipito-orbital bristles partly black and partly white. Thorax gray pollinose, mesothoracic dorsum with black hairs and bristles, scutellum with black bristles; wings hyaline with pale veins. Femora uniformly black all over, tibiae pale on the basal parts, otherwise dark, nearly black, as are all the tarsi.

Basal part of the abdomen largely dark in ground color and gray pollinose, last three segments red in ground color and gray pollinose. Male genitalia slightly shorter than the last two abdominal segments combined, rather small and compact; appendages red, from lateral view of nearly the same width throughout and rounded at the apex.

The entirely hyaline wings, the uniformly black femora and the small size of the specimens make the species easy of determination. The female genitalia shining black with a distinct circlet of spines at the tip.

The male type and two other males and four females from San Jose, Mexico, collected by D. L. Crawford and McConnell.

Proctacanthus philadelphicus Macquart.

Total length 28 to 36 millimeters. Mystax dark yellow, usually with some black bristles intermixed, beard slightly paler than the mystax, palpi black and mostly with black hairs; occipito-orbital bristles part black and part yellow. Thorax rusty brown pollinose, mesothoracic dorsum with short black hairs anteriorly and with black bristles and hairs posteriorly, scutellum with numerous black bristles and hairs and often with a few white hairs intermixed. Legs in most part brown with black bristles and pale hairs, femora darkest anteriorly, wings uniformly brown all over. Abdomen rusty brown pollinose. Male genitalia slightly shorter than the last two abdominal segments combined, appendages brown, from side view nearly straight and near the same width throughout, the tips rounded but not curved towards each other. Female genitalia shining black, end piece rather broad, sparsely hairy and with a circlet of strong black spines.

The intense brown color of the body and wings and the dark yellow mystax are characteristic of the species.

Specimens from New Jersey, Maryland, Connecticut, Massachusetts, Virginia and Pennsylvania.

Proctacanthus longus Wiedemann.

Total length 32 to 36 millimeters. Mystax yellow, beard paler than the mystax, palpi black with paler hairs, occipito-orbital bristles part black and part pale. Thorax brown, gray pollinose, mesothoracic dorsum with the usual markings rather plainly shown, anterior part mostly with short black hairs, posterior part with black bristles, scutellum with black bristles and hairs; legs brown with black bristles and numerous pale hairs; tibiae slightly lighter than the femora; wings uniformly brown, wide and rather long. Abdomen brown, brownish gray pollinose, male genitalia shorter than the last two abdominal segments combined, from side view appendages nearly straight, of nearly uniform width with the tips rounded but not curved toward each other when viewed from above; female genitalia black with a terminal circlet of strong spines.

Related to philadelphicus but the pale hairs of the palpi, long, wide wings and more grayish pollinosity of the body serve to characterize it.

Proctacanthus craverii Bellardi reported from Mexico, from the description, I take to be a synonym.

Specimens at hand from Georgia, Florida and Texas.

Proctacanthus milbertii Macquart

Total length 28 to 40 millimeters. Mystax pale yellow, beard paler than the mystax, palpi black with black hair. Thorax gray pollinose, mesothoracic dorsum with the usual markings rather plainly shown, scutellum with black bristles and usually with a few pale hairs; wings uniformly light brown; legs brown, tibiae and tarsi lighter than the femora which are darker anteriorly than behind. Abdomen gray or in some cases brownish gray pollinose. Male genitalia shorter than the last two abdominal segments combined, appendages not curved toward each other at the tips; ovipositor usually black but occasionally red or partly red, with a circlet of strong spines at the tip.

Related to philadelphicus, but the mystax and wings are paler; the abdomen is gray and not brown pollinose and the thoracic markings are rather more distinct.

Specimens from western Ohio, Indiana, Wisconsin, Kansas, Missouri, Michigan, Colorado, California and British Columbia. It is one of our most common and widely distributed species.

Under the name Asilus missouriensis, Riley has written of this species as a distinct enemy of bees.

Proctacanthus nigriventris Macquart.

Total length 30 to 35 millimeters. Body very dark, nearly black; wings uniformly rather pale brown. Mystax very pale yellowish, often with black bristles intermixed, beard gray, occipito-orbital bristles black. Thorax dark, brown pollinose, mesothoracic dorsum with black hair and bristles, usual markings not plainly differentiated; scutellum with black hairs and bristles. Wings uniformly rather pale brown, legs dark nearly black; femora, except the apices, black, apexes of femora, tibiae and tarsi dark brown. Abdomen dark, nearly black, dark pollinose with a narrow band before each incisure light pollinose, venter and sides of the last two or three segments in the male gray pollinose; male genitalia dark red, rather short, appendages widest at the base, gradually narrowed toward apex where they are evenly rounded; ovipositor shining black with strong black spines at the tip.

The very dark color of the whole body is distinctive.

Specimens from New Jersey, collected by H. S. Harbeck, of Philadelphia.

Proctacanthus brevipennis Wiedemann.

Total length 20 to 28 millimeters. Mystax usually white but sometimes yellowish and occasionally largely black, in any case there is likely to be more or less black bristles mixed with the others, beard white, palpi with black hair, occipito-orbital bristles mostly black. Thorax brown, gray pollinose, mesothoracic dorsum with the usual markings very plainly differentiated, anterior part with short black hairs, posterior part with numerous black bristles; scutellum with black bristles and a few white hairs before. Wings uniformly pale brownish; legs brown, tibia and tarsi lighter than the femora, which are nearly black before and brown behind. Abdomen rather dark colored, more or less gray pollinose, male genitalia red, rather short, small, of nearly the same width throughout and evenly rounded at the tips. Ovipositor shining black, except occasionally when it is more or less red, with a distinct circlet of spines at the tip.

The small size and plainly differentiated thoracic markings are usually sufficient to place specimens of this species.

Specimens at hand from North Carolina, Kansas, New Jersey, Florida, and Georgia. The type of the species was taken in Kentucky.

THE GENUS PROMACHUS.

In 1838 Macquart described the genus Trupanea to receive the species which fall here. Ten years later Loew discovered that Macquart's name could not stand on account of previous usage and proposed Promachus to take its place. The species are large, although somewhat smaller than the species of Proctacanthus. The bristles of the antennae are naked, the veins closing the discal and fourth posterior cells are not parallel, the posterior branch of the third vein terminates beyond the tip of the wing, there are three submarginal cells and the abdomen is longer than the wings. These characters will place the species easily in most cases but certain species of Mallophora may cause trouble. In case they do the fact that the members of the latter genus have obtuse claws, while those falling under Promachus have pointed claws should obviate the difficulty. There are at least nineteen valid species of the genus described from North America, but since five of these from Mexico and Central America could not be procured only fourteen are treated in this paper. The genus appears to reach its greatest development to the southward and I have reasons for believing that there are yet in North America several undescribed species.

KEY TO THE SPECIES OF PROMACHUS.

1. First submarginal cell with a gray shadow which sometimes is very narrow..2
   First submarginal cell without any trace of a gray shadow.....12
2. Male genitalia with dense silvery hair above, color of the tibiae very near like that of the femora.....6
   Male genitalia without silvery hair above, color of the tibiae usually in striking contrast to that of the femora.....3
3. Gray bands on the dorsum of the abdomen fully as wide as the black bands..4
   Gray bands on the dorsum of the abdomen confined to narrow posterior borders of the segments.....5
4. Thorax deep reddish brown, male genitalia clothed with black hair..**rufipes**
   Thorax yellowish gray, male genitalia clothed with gray hair....**vertebratus**
5. Gray shadow in the first submarginal cell less than half as wide as the cell; male genitalia rounded at apex.....**sackeni**
   Gray shadow in the first submarginal cell darker in color than usual, distinctly more than half as wide as the cell; male genitalia truncate at apex **forfex**
6. Abdomen with black hair on some or all of the first five segments above..9
   Adbomen without black hair on any of the segments above.....7
7. Abdomen uniformly clothed with short gray hair, mystax very pale yellow or nearly white, beard white.....**truquii**
   Abdomen clothed with yellow hair, beard and mystax distinctly yellow....8
8. Gray shadow in the first submarginal cell wider than the marginal cell, male genitalia almost as long as abdominal segments five, six and seven combined..... **fitchii**
   Gray shadow in the first submarginal cell distinctly narrower than the marginal cell, male genitalia shorter than abdominal segments six and seven combined ..... **quadratus**
9. Mystax white or with a very slight shade of yellowish, legs chiefly black..10
   Mystax plainly yellow, legs chiefly yellowish red.....11
10. Abdomen densely brown pollinose on the sides.....**albifacies**
    Abdomen gray pollinose on the sides and extending across narrowly on the hind margins of the segments.....**princeps**
11. Abdomen densely brown pollinose on the venter and sides, wings plainly brownish.....**bastardii**
    Abdomen pale yellowish gray pollinose on the venter and sides, wings nearly hyaline..... **quadratus**
12. Legs pure black.....13
    Legs more or less reddish.....14
13. Abdomen distinctly banded with black and gray, the gray bands slightly more than half as wide as the black.....**nigripes**
    Abdomen not distinctly banded, although the narrow posterior margins of the segments are somewhat different from the other parts by appearing whiter..... **aldrichii**
14. Very large species, 35 to 40 millimeters in length.....**giganteus**
    Small species, not over 25 millimeters in length.....**minusculus**

Promachus vertebratus Say.

Total length 26 to 31 millimeters. Front and face clothed with yellow pollen, hairs and bristles of the whole head yellowish, beard paler than the mystax, often some of the bristles on various parts of the head are black but there does not appear to be any uniformity as to which ones are black and often there are none of this color. Proboscis shining black, palpi clothed with yellowish hair with an intermixture of black in some specimens, antennae black. Thorax yellowish pollinose, dorsum with a brown stripe at the middle divided by a narrow gray line, wings dilute brownish; legs somewhat variable in color, clothed with black bristles and recumbent pale hair, femora in large part black although they may be almost entirely reddish, or even only

reddish in part; tibiae reddish with the extreme apices darker; all of the tarsi brown or black. Abdomen largely gray pollinose and clothed with pale hairs; dorsally the first six segments each have a rectangular black marking which occupies about the anterior half of its respective segment. Male genitalia black, clothed with pale hair, female genitalia shining black.

Specimens from Kansas, Wisconsin, Illinois and Ohio.

Promachus rufipes Fabricius.

Total length 28 to 35 millimeters. This is a larger species than vertebratus. The color of the thorax is much browner than in that species and the color of the wings is more pronounced. The palpi are black with black hair and the hypopygium is shining black with scattering black hairs. The legs are somewhat variable, or at least in the specimens before me they show two distinct types of coloration. The specimens that agree closer to the original description have pure black femora and reddish yellow tibiae with black apices. In another set of specimens the femora and tibiae, except the apices, are reddish brown throughout and do not show any contrast. In other respects the two series of specimens exactly agree and I prefer to consider them all rufipes.

Specimens at hand from District of Columbia, Tennessee, Mississippi, Iowa and Ohio.

Promachus sackeni n. sp.

I take this to be Promachus No. 2, Biolog. Cent. Am., Volume I, page 193.

Total length 22 to 27 millimeters. Mystax composed of black and yellow bristles intermixed, palpi black, mostly with black hairs but there may be light colored ones intermixed, especially on the basal parts, beard white, thorax gray pollinose above with the usual markings, wings uniformly pale brownish, the dark marking in the first submarginal cell very little more than one-fourth as wide as the cell at the widest part, femora, apex of the tibiae and the tarsi black with black bristles, remainder of the tibiae yellowish red with numerous pale hairs and a few black bristles, claws pointed and distinctly curved. Abdomen with much yellowish hair which on the sides is rather long; segments two to seven in the male and two to five in the female with gray pollinose triangles on the sides, the inner angles on each side meeting above on each of segments two to five in both sexes and forming a posterior gray band; the hypotenuse of each triangle is slightly concave, leaving on each segment a semicircular spot which is clear black; hypopygium black, slightly wider than the abdomen, evenly rounded posteriorly, with mostly black hairs dorsally and pale yellow hairs laterally; ovipositor black, somewhat longer than abdominal segments four and five.

Three males and three females from southern Arizona, in July and August, some of them collected by the late Dr. F. H. Snow.

Osten Sacken's specimens were procured in northern Sonora, Mexico, by Morrison. In a note after his description he mentioned Promachus trapezoidalis Bellardi as closely related, but Williston has shown, rightly I think, that the latter belongs to Mallophora. I have seen a male of this from Brownsville, Texas. Bellardi mentions the blunt claws and Williston calls attention to the same character.

Promachus forfex Osten Sacken.

This is a new name for Promachus quadratus Bellardi, since there is an older quadratus by Wiedemann.

Total length 23 to 30 millimeters. Mystax largely composed of yellow hair, but a few of the finer ones are black, antennae and proboscis black, palpi with black hair, occipito-orbital bristles black. Thorax sparsely gray pollinose with the usual darker markings dorsally, scutellum with two more or less irregular rows of black bristles and numerous shorter yellow hairs; wings uniformly yellowish brown, distinctly darker than in sackeni, cloud in the first submarginal cell two-thirds as wide as the cell, dark colored and with a distinct outline; femora, tips of the tibiae and tarsi, including the claws pure black, remainder of tibiae and pulvilli yellow, balancers pale yellow; abdomen largely clothed with light yellow hair, sides and narrow posterior margins of the first five segments in the female and seven in the male gray pollinose leaving a large quadrate dark marking above on each of the segments. Ovipositor composed of three segments, shining black; hypopygium black with black hair, from dorsal view gradually widened toward the apex where it is plainly truncate.

Male and female from Cordoba and a female from Veracruz in Mexico, collected by D. L. Crawford. Also a female from Puerto Barrios, Guatemala, collected by E. B. Williamson. The species appears to be southern in distribution and is not likely to be taken in the United States.

Promachus fitchii Osten Sacken.

Fitch described this species under the name apivora because he found it injurious to bees. His name could not stand, however, as it had been used before in the genus.

Total length 25 to 30 millimeters. Mystax, beard and hairs of the palpi distinctly yellow, occipito-orbital bristles pale yellow intermixed with black ones which are more numerous in some specimens than in others. Thorax yellowish brown pollinose above with short black

hairs anteriorly and longer black hairs and bristles posteriorly, a tuft of yellowish hairs before the scutellum in well preserved specimens, scutellum with numerous yellow hairs and a few black bristles; legs mostly yellowish red although usually there is a black or blackish area on the front side of each femur; hairs of the legs yellow, bristles black; wings with a pale brownish tinge, shadow in the first submarginal cell plainly evident, a little more than a third of the width of the cell at the widest part, ground color of the abdomen black, uniformly clothed with rather short yellow hairs all over.

The long hypopygium is clearly distinctive in this species. It is nearly twice as long as in any other species I have seen.

Numerous specimens from Clay County, Kansas, collected by Prof. J. H. Schaffner. Aldrich catalogues it from Nebraska, Missouri, Kansas, Connecticut and Florida.

Promachus albifacies Williston.

Total length 22 to 28 millimeters. Mystax and beard white, at most only a few black hairs on the oral margin; palpi with many black hairs and usually with some scattering white ones among them; rear of the head with white hairs and a few black bristles above. Thorax brown pollinose with the usual stripes above, a tuft of white pile in front of the scutellum largely surrounded by black bristles, scutellum with numerous white hairs and black bristles; wings nearly hyaline, gray shadow in the first submarginal cell less than one-third as wide as the cell at the widest point; legs largely black but somewhat variable, often the femora are red posteriorly and the same may be said of each tibia at base. Abdomen pure black in ground color, distinctly brown pollinose on the venter and sides and on each side of each segment are numerous white hairs which tend to reach across the dorsum and form a very narrow hind border to the segment. Hypopygium small, short and clothed above with abundance of silver white pile.

The species is known from California, Colorado, Arizona, New Mexico and Mexico.

Promachus princeps Williston.

Total length 27 to 32 millimeters. Mystax white with a few black bristly hairs on the oral margin, beard white, palpi with numerous black hairs and a few white ones, rear of the head with white hair and some black bristles above; thorax gray pollinose, wings hyaline, gray shadow in the first submarginal cell very narrow and usually not sharply defined, legs approaching black, each femur posteriorly and each tibia at the base more or less dark reddish; abdomen black in ground color, gray pollinose on the sides and venter, with an area of white hairs on each side of each segment and these tend to approach each other and unite and thus form a band across the posterior margin of the segment. The abdomen is somewhat variable when different specimens are compared on account of the area covered with white hair.

This species may be separated from albifacies by the gray instead of brown pollinosity of the thorax, and sides and venter of the abdomen, by the wings being more nearly hyaline and by the gray shadow in the first submarginal cell being narrower and less sharply defined than in that species.

The species is known from California, Oregon and Washington.

Promachus bastardii Macquart.

Asilus laevinus, Trupinea rubiginis and Asilus ultimus of Walker, and Promachus philadelphicus Schiner are considered synonyms.

Total length 21 to 28 millimeters. Mystax and beard yellow, the latter paler than the former, palpi clothed with black hair, occipito-orbital bristles black; thorax brown, the usual markings present on the dorsum but not very plainly shown, legs in general color red with white hair and black bristles; in most specimens there is a black stripe of greater or less width on the anterior side of each femur, and the front legs especially may have more or less yellow pile on the tibiae and tarsi; wings quite distinctly uniformly brownish, shadow in the first submarginal cell about half as wide as the cell at the widest part, not very dark gray but with definite limits. Abdomen distinctly brown on the venter and sides and clear black above. From dorsal view the abdomen shows a very narrow band of white hair on the posterior margin of each segment and black hairs on a clear black background otherwise.

The hypopygium is clothed with silvery white hair above but is distinctly wider than in albifacies and princeps.

Specimens have been taken in New York, Massachusetts, Pennsylvania, Michigan, Kansas, Georgia and Ohio.

Promachus quadratus Wiedemann.

Total length 22 to 29 millimeters. Mystax and beard yellow, the latter distinctly lighter than the former, palpi black with yellow hair, but with a few black ones intermixed, rear of the head with yellowish hair, occipito-orbital bristles black. Thorax light brown pollinose with the usual middorsal stripe and lateral markings; wings very pale yellowish all over, shadow in the first submarginal cell narrow, hardly one-fourth as wide as the cell at the widest place; legs brown with light hair and black bristles, anterior part of each femur darker than the other parts of the leg; balancers brown. From above each abdominal segment has a rather wide posterior margin which is clothed with pale yellowish or white hair and which widens distinctly towards each side. The ground color of the abdomen is black and the color shows plainly on the anterior part of each segment but not so extensively as in bastardii. In the male the genitalia is of medium size and clothed above with silver white hair as in related species.

There has been some uncertainty in regard to quadratus but these specimens agree well with the original description. In comparison with bastardii the color as a whole is lighter, the palpi are clothed with mostly yellow hair instead of mostly black hair, the wings are much nearer hyaline, the gray shadow in the first submarginal cell is much narrower and the abdomen has much more light hair. Weidemann's type is recorded as from Georgia.

Specimens are at hand from Cameron Parish, Louisiana.

Promachus truquii Bellardi.

Total length 24 to 36 millimeters. Mystax pale yellowish, beard white, rear of the head with white hair, occipito-orbital bristles mostly black, palpi with many black hairs but beneath there are a number of pale yellow ones; thorax brown pollinose, sides with white hairs, dorsum with many short black hairs anteriorly and rather long white hair and black bristles posteriorly; legs in large part reddish brown with white hair and black bristles, anterior side of each femur largely black; wings nearly uniformly pale brownish, hardly as dark as in bastardii, gray shadow in the first submarginal cell plainly evident and with distinct limits, about a third as wide as the cell at the widest place. Abdomen brown pollinose on the venter and sides, black dorsally, uniformly clothed all over with short white hair, no black hair except a few black bristles on either side of the first segment. The hypopygium is furnished with silvery hair above very much as in albifacies.

The most apparent difference bewteen this and related species is the uniform distribution of rather short white hair over the abdomen and the absence of black hair except the black bristles on the sides of the first segment.

Several specimens from the Huachuca Mountains, Arizona. Besides the species has been reported from several places in Mexico.

Promachus nigripes n. sp.

Total length 28 to 32 millimeters. Mystax and beard white, rear of the eyes with white hair, occipito-orbital bristles largely black, palpi black with numerous black hairs and a few white ones on the lower side, antennae black. Thorax gray pollinose, mesothoracic dorsum with the usual markings not conspicuous, clothed largely with black hair and bristles, sides of the thorax with long gray hairs, scutellum with black hair and bristles; legs black, mainly with black hair and bristles, but there may be some white hairs especially on the femora; wings hyaline, no gray shadow in the first submarginal cell. Abdomen from above banded with black and white, a white pollinose band clothed with white hair on the posterior part of each segment and a wider black hand clothed with black hair before it, venter and sides white

pollinose with white hairs. Hypopygium rather wide and clothed above with silvery hair, posterior ventral margin of the eighth segment with black and white hairs.

There is some variation among the different specimens. The hair on the posterior part of the mesothorax may be largely white, the legs may vary in the extent of the white or black hair present, although the bristles are always black, and in the male the margin of the eighth ventral segment may be furnished entirely with black hairs.

The distinct limitation of the black and white areas on the dorsum of the abdomen so as to form bands, together with the entirely black legs characterize the species.

The male type and seven other males and females taken at Albuquerque, New Mexico, by J. R. Watson.

Promachus aldrichii n. sp.

Total length 28 to 30 millimeters. Mystax and beard white, occipito-orbital bristles mostly black, palpi black with white hairs, only a few black ones above. Dorsum of the mesothorax mainly with black hairs, and bristles, but there is some rather long white hair on the scutellum and before it, prothorax gray pollinose, usual markings present but they are not very plainly shown; legs black, clothed with black and white hair and black bristles; wings clear hyaline, no shadow in the first submarginal cell; abdomen black in ground color, gray pollinose on the sides and venter and clothed everywhere with rather short hair which is almost all white, there being only a very few short black hairs on the anterior dorsal part of each segment. In the male the posterior ventral margin of the eighth adbominal segment is furnished with a fringe of white hairs and the hypopygium is silvery pilose above.

The most characteristic thing about the species is the uniform distribution of the white hairs on the abdomen so that this part does not appear evenly banded as in nigripes.

The male type and one female from Utah, and received from J. M. Aldrich of Moscow, Idaho.

Promachus minusculus n. sp

Total length 24 to 26 millimeters. Mystax and beard pure white, palpi black with some black and some white hairs, occipito-orbital bristles largely pale although there are always a few black ones intermixed. Thorax gray pollinose, thoracic dorsum with the markings not very distinct, clothed with black and white hair and black bristles, bristles of the scutellum partly white and partly black, wings pure hyaline, veins brown. Legs dark reddish in general coloration, femora darkest anteriorly, tibiae red, tarsi nearly black, all the parts clothed with reclining white hairs and black bristles. Abdomen rather dull black in general coloration, venter, sides and posterior part of the dor-

sum of each segment clothed with white hairs, anterior part of the dorsum for more than half the length of each segment clothed with black hairs. Hypopygium small and clothed both above and below with rather long silvery white hair, ovipositor black.

Easily known from other species of its group by its small size and general rather light color as well as by the very small hypopygium which is densely clothed with silvery hairs below as well as above.

Male type and five other males and females taken near Albuquerque, New Mexico, by J. R. Watson.

Promachus giganteus n. sp.

Total length, male 37, female 41, millimeters. Mystax and beard white, hair of the rear of the head white, occipito-orbital bristles mostly black, palpi black, largely with white hairs, but there are some black ones above, antennae black; general color of the thorax reddish brown, mesothoracic dorsum with a rather wide middorsal black stripe which is divided lengthwise by a narrow red interval, on either side is a second black area which is divided by a narrow red space which follows the transverse suture. As the surface of the dorsum of the mesothorax is somewhat denuded in the specimens studied it is likely that the markings described are plainer than would be the case otherwise, scutellum clothed with white hair and with two rows of black bristles near the margin; legs in large part dull reddish and clothed with black bristles and recumbent white hair, tarsi nearly black, femora darkened anteriorly; wings hyaline, no gray shadow in the first submarginal cell, veins brown and some of them towards the apex very narrowly margined with a nearly obsolete brownish shade. Abdomen as seen from above alternately banded with black and white, the former color usually wider than the latter. The black and white is segmentally arranged, the anterior part of each segment is black with black hair and the posterior part is white pollinose with white hair, sides and venter of the abdomen corresponds in color with the posterior parts of the segments. In the male the hypopygium is silvery pilose above and the posterior ventral margin of the eighth abdominal segment is furnished with a thickly placed row of white hairs.

The species cannot be mistaken among described North American species on account of its very large size.

The type female and one male taken at El Paso, Texas, by D. L. Crawford, and received from Carl F. Baker, of Pomona College, Claremont, California.

LOCOMOTION OF THE LARVA OF CALOSOMA SYCOPHANTA.*

By A. F. Burgess.
Bureau of Entomology, Melrose Highlands, Mass.

Among the interesting data in the report on "The Gypsy Moth," by Forbush and Fernald, which was published by the Massachusetts State Board of Agriculture in 1896, will be found a record of a series of experiments to determine the distance which young gypsy moth caterpillars will travel. Seven caterpillars were used, and it was found that the distance they crawled before dying ranged from 36 to 144 feet. Another record of experiments conducted with another insect is given on page 23 of bulletin 72 of the New York State Museum, which is bulletin 19 on entomology, published in 1903. In it Dr. Felt writes concerning the grape root worm that he carried on "some experiments to determine the burrowing and traveling power of these little creatures. One small grub was placed on a piece of paper at 9.27 in the morning and its wanderings were carefully traced with a pencil till 4.43 in the afternoon. The little creature traveled almost continuously during the entire period and showed a decided tendency to turn to the left. It covered the relatively enormous distance of over 47 feet in seven hours, or an average of about 2 yards an hour. The grub was placed in a dry vial and under such unfavorable conditions lived about three days."

These experiments show that insect larvae are able to survive for a much longer time than would be expected, and to do so under adverse conditions. The ability to travel until food is secured being absolutely necessary to the existence of the individual this factor plays a very important part in determining the ability of larvae to survive, and especially is this true of predaceous forms. Our attention was strongly directed to this matter in connection with the work of importing and colonizing certain predaceous enemies of the gypsy and brown-tail moths in Massachusetts. The ability of the larvae of *Calosoma sycophanta*, a predatory species which has been received from Europe, to travel any great distance in search of food is of para-

* Read at the Minneapolis meeting, Dec. 28, 1910, in joint session with the Association of Economic Entomologists.

mount importance to the well-being of the species, and although the insects had been found to be very active in breeding jars it seemed worth while to secure more accurate data as to their powers of locomotion. Accordingly, a set of experiments was planned to determine the distance that a larva of this species would travel from the time of hatching until it died, provided no food or moisture was supplied. In order to carry out the test it was necessary to do so under conditions which never occur in nature, but the results indicate the practical impossibility of carrying on tests over so long a period unless absolute control is secured, so that a careful record can be made.

The following apparatus was used (Plate XIII): A small table 3 ft., 8 in. long, by 2 ft. wide was provided with spools at each end near the top, so that a roll of paper could be reeled across the top of the table, the result being accomplished by turning the spools. Beneath this paper was placed a piece of stiff wrapping paper which extended beyond the sides of the paper connected with the reels, and the edges were bent upward in such a manner as to prevent the escape of the larva from the sides of the table. The paper on the reels was ordinary wrap-

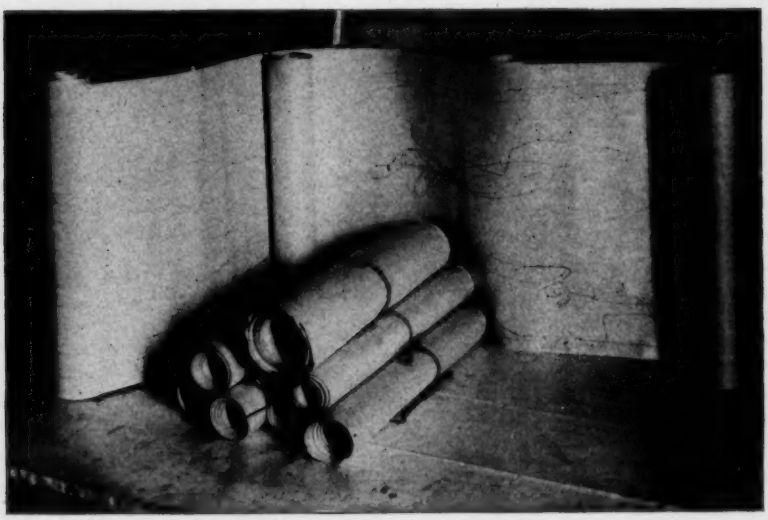

Fig. 1. Rolls of Records.

A. F. Burgess.

ping paper 18 inches wide. The larva was placed in the center of the table and a record of its travels was made with a lead pencil.

At 8:30 A. M., June 18, a newly hatched larva was placed in the center of the table by Mr. C. W. Collins, and the record was kept throughout the day with the assistance of Mr. R. G. Smith. The table had been placed in an attic room in the laboratory, having only one window, which was on the west side of the house. During the day the larva moved rapidly away from the light, and when it had reached the end of the roll the table was turned end for end and the insect began traveling in the opposite direction. Although there were forty yards of paper on this roll, it was necessary at 1 P. M. to remove the larva and substitute a fresh roll, as it had crossed the paper from end to end five or six times.

The complete record of the travel of this larva required 11 rolls of paper and one assistant and sometimes two, depending on the activity of the insect, had to be constantly at work. (Fig. 1.) The experiment was carried through continuously until the larva died, and the extraordinary vitality which it exhibited, promised, at one time, to exhaust the supply of assistants that could be spared for the work.

The following table gives the data secured from the record on each roll.

Time	Total	Distance	Rate per min.
8.30 a. m. to 1 p. m.	4½ hrs.	1323.63 ft.	4.9 ft.
1 p. m. to 4.40 p. m.	3 2-3 hrs.	719.40 ft.	3.27 ft.
4.40 p. m. to 9. 40 p. m.	5 hrs.	1213.14 ft.	4.04 ft.
9.40 p. m. to 1.45 a. m.	4½ hrs.	1164.51 ft.	4.75 ft.
2 a. m. to 8 a. m.	6 hrs.	733.17 ft.	2.03 ft.
8.40 a. m. to 11.40 a. m.	3 hrs.	926.03 ft.	4.03 ft.
11.54 a. .m to 4.40 p. m.	4 23-30 hrs.	933.15 ft.	3.26 ft.
5 p. m. to 10.15 p. m.	5¼ hrs.	712.15 ft.	2.26 ft.
10.35 p. m. to 2.05 a. m.	3½ hrs.	575.91 ft.	2.74 ft.
2.15 a. m. to 1.30 p. m.	11½ hrs.	786.5 ft.	1.13 ft.
1.30 p. m. to 8.45 a. m.	19¼ hrs.	190.44 ft.	.16 ft.

The larva remained alive from 8:30 Saturday morning until 8:45 Tuesday morning, 72 hours, and was active the greater part of the time. It was necessary to place the insect in a glass each time a new roll of paper was attached, so that the entire length of time that the larva was actually on the paper was about 70 hours. The table gives the distance traveled during different periods, the total amounting the 9,058 feet, or 1.71 miles.

The highest rate of travel per minute was during the first 4½ hours, and averaged 4.9 ft. For the first 24 hours the average was 3.69 ft. per minute; during the next 8 hours the average dropped slightly and for the remaining period the average was gradually reduced until the larva died.

The temperature in the room where the experiment was conducted ranged considerably higher than that outside the building, the following records being taken from the report of the U. S. Weather Bureau at Boston.

June 18—	Maximum,	79	degrees;	Average,	70	degrees.
" 19—	"	75	"	"	68	"
" 20—	"	86	"	"	74	"
" 21—	"	92	"	"	80	"

The larva was kept continually on a dry surface, so that evaporation was very rapid, and doubtless reduced the length of time that the insect would have survived under normal conditions.

For the first 36 hours the larva traveled almost continuously, stopping only occasionally for a minute or so to rest.

During this time it traveled away from the light, viz., from the window during the day time, and at night away from the single electric light which was in the room. On the second night, which was after 36 hours of continuous travel the larva began traveling toward the light, and continued to do so during the night.

Mr. R. G. Smith, who was on duty at the time, noted that from 8 A. M. on June 20, the larva traveled at a continuously decreasing speed. Marks were made showing direction of travel, and every fifteen minutes the time was noted on the lines of travel. Resting periods: 4.32 P. M., 8 minutes; 4.45 P. M., 5 minutes; 5.15 P. M., 10 minutes; 5.46 P. M., 12 minutes; 6.36 P. M., 4 minutes; 6.42 P. M., 7 minutes. The larva moved only several inches at a time. In the morning the larva rested often, but only for a few minutes at a time. Mr. J. J. Culver noted that about 11 P. M., June 20, the larva began to crawl backwards, at intervals bending the head down as if trying to bite itself. It would do this for two or three minutes, then either rest or crawl in the normal manner. At this time the larva had become either insensible to light, or too weak to continually travel from it, as it traveled toward the light as much, if not more, than from it. In backing the larva always moved from the light.

At 12.45 A. M., the larva was very weak, it had scarcely moved during the last hour, and remained in a humped-up position. If touched with a pencil point, it would jump, but would not move either forward or backward. Between 8.25 P. M., June 20, and 1.40 A. M., June 21, the larva rested 4 hours, 15 minutes.

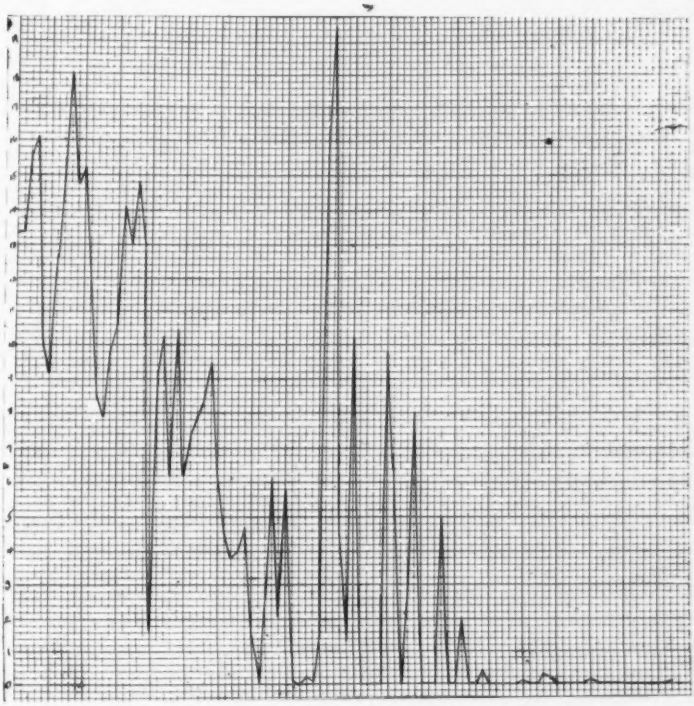

FIG. 2. Distance traveled by larva during the last twenty-four hours. Figures at left indicate number of feet each small horizontal space indicates a fifteen minute interval.

Mr. H. E. Smith, who was on duty at the time, noted that the larva did not move from 1.45 A. M. to 2.30 A. M., when it backed ¼ of an inch, remaining thus until 3.25 A. M., when it turned half way round in its tracks. The line from 1.45 A. M. to 4 A. M. was all backed over, except in a small circle which was traveled in the normal manner. At 3.55 A. M. the larva fell

on its back and remained so until 4.05 A. M. when upon being touched in order to test life it grappled the lead pencil point and again regained its footing. It moved and backed in a small circle at 5.15 A. M. At 7.05 A. M. it fell on its back again, and remained there until it died at 8.40 A. M., June 21.

The rate of travel from 8.30 A. M., June 20, to 8.40 A. M., the following morning, which was the last twenty-four hours of the insect's life, is shown in the diagram (Fig. 2.) and illustrates how remarkable was the activity until almost the close of its life.

No delicate balances were available for weighing the larva after it hatched, but as soon as it died it was weighed by Mr. W. G. Fall, of the Massachusetts Department of Weights and Measures in Boston. The average weight of ten newly hatched larvae was .2973 grains; the weight of the dead larva was .18 grains, which indicates that it lost .1173 grains during the experiment.

Although the distance traveled is probably much greater than what would actually occur in nature, it is remarkable that so much latent energy can be stored up in an egg of one of these beetles. It is interesting to compare the ability to travel possessed by this larva with that of some of the higher animals. Through the courtesy of Dr. W. E. Castle and his assistant Mr. Detlefson, of the Bussey Institution, of Harvard University, we have been able to secure measurements and weights of young rats and guinea pigs and this information is used in making the comparison. The average length of all the legs of the larva of *Calosoma sycophanta*, ten specimens having been measured, was 3.37 mm., that of a young rat, one to three days old twelve specimens having been measured, was 19.08 mm., or 5 2-3 times greater, while similar measurements of a guinea pig showed that the average length of leg was 76.25 mm., or 22½ times greater than that of the beetle larva. If the ability to travel of the higher animals mentioned equalled that of *sycophanta*, the rat would be able to cover nine miles without food or water, while the guinea pig would have to cover over 38 miles under the same conditions. It might be said that the locomotive powers of a young guinea pig are superior to that of a rat of the same age but doubtless either would die before traveling a very short distance to obtain food.

If the traveling capacity is compared on the basis of weight the difference is much greater. The average weight of the beetle larva is 19.8 m. g., that of the rat 5250 m. g., and that of the guinea pig 7500 m. g. Thus if the rate of travel was in the same proportion the rat would cover 453 miles and the guinea pig 648 miles while the larva traveled 1.71 miles.

The length of life of the insect is also worthy of note when it is remembered that no food or water was supplied, as it indicates that the young larvae are able to survive several days in the field without food and still have sufficient vitality to make a thorough and active search for their prey.

DISCUSSION.

MR. J. B. SMITH: The thing that interested me most is the appropriateness of the German name, "laufkafer." Mr. Burgess' paper shows that the German name is absolutely correct when applied to the larva of this insect, because it certainly can run.

MR. HOWARD: It is estimated that there are now over a million of these insects in Massachusetts, that next year there will be ten millions, and the year after one hundred millions.

MR. J. B. SMITH: Dr. Howard's remark recalls to my mind the following experience: In south New Jersey there was one season an outbreak of a species of Geometrid caterpillar, which covered the scrub oaks in enormous numbers, and that season, in company with two or three entomologists, I was down in the region where the insects occurred. We found *Calosoma* of two species, *willcoxi and scrutator*, were present in enormous numbers on the young oak trees, feeding upon these larvae. The next year you could look through the whole territory and could not find a single specimen of either species.

MR. BURGESS: I think a possible explanation might be that, as far as we know the larvae of *Calosoma willcoxi* and *scrutator* do not climb trees, while the larva of *sycophanta* does so very readily.

MR. SUMMERS: This certainly is an interesting paper, but the point that is perhaps the most interesting is the comparison of the rat and the guinea pig. It seems to me that is a fallacy

that ought to be pointed out. If a man could jump, in comparison to his size, as far as a flea, he could jump over a church tower. One might say too much on the relative endurance of animals, of the distance they can travel, unless the animals are of the same size, or unless the law of reduced power of locomotion with added weight and size is taken into account. The rat with the same endurance, I believe, could not travel the distance stated in the paper.

NOTES ON THE PEAR-SLUG.*

Eriocampoides limacina Retz.

By R. L. Webster.

Recent Injury. Nearly every year cherry and plum trees in Iowa suffer much injury by the common pear-slug. While the control of this insect has never been considered a difficult problem, yet it happens frequently that foliage is greatly damaged before one is aware that any slugs are present.

Serious damage is sometimes caused to cherry trees. Young cherry trees in the town of Ames have been killed as a result of defoliation following the injury by the slugs.

Appearance of the Injury. The slugs feed on the upper surface of the leaves, eating the parencyhma and leaving only the veins and the lower epidermis. Leaves thus eaten, dry, turn brown, curl up and fall from the tree. Frequently infested trees are left entirely bare of foliage in midsummer.

The Insect's Appearance. The insects in question are dark, olive colored slugs, with a slimy covering. The fore part of the body, just back of the head, is broad, but it tapers back of this. Where the slugs are common a peculiar sour odor may be noticed.

The slugs molt five times, and when mature they are about 2-5 of an inch long. After the last molt the slug has a clean and dry skin, quite free of slime, and orange in color. These orange slugs go to the ground and form small earthen cells in which to pupate. When the adult sawflies emerge they deposit eggs in the tissue of plants on which the young slugs are to feed.

PAST HISTORY AND DISTRIBUTION.

This insect has long been known in Europe. As far back as 1740 Reaumur gave an account of the pest and its injury. The first American account was written by Prof. Wm. D. Peck, of Harvard, and published in 1799.

Professor Peck wrote an essay on the insect, entitled the "Natural History of the Slug-Worm," which won for him a gold medal and a prize of fifty dollars, given by the Massachu-

* Read at the Minneapolis Meeting, Dec. 28, 1910, in joint session with the Association of Economic Entomologists.

setts Society for Promoting Agriculture. The essay was printed by the Society but it has now become very scarce. Harris, writing in 1841, said that the pamphlet was then "out of print and rarely to be met with." It was the good fortune of the writer to find this paper of fourteen pages in the Boston Public Library last winter. That so much concerning the habits of this insect had been determined at such an early date in the history of American economic entomology, is indeed surprising. In fact, almost all of the information concerning the insect in America dates back to the account of Peck.

The insect is widely distributed, having been recorded in Europe, North America, Australia, New Zealand and South Africa.

LIFE HISTORY.

GENERATIONS. There are in central Iowa two quite distinct generations of the insect. In the fall a very few slugs were found, lagging way behind the others, but these are probably only delayed individuals from the second generation, rather than a partial third generation.

About Ames the eggs and adults were found in late May and early June and larvae appeared in the fore part of June. By July 5 the first brood slugs were practically all gone. The adults from this brood of slugs appear about the middle of July and their eggs hatch late in the month. The slugs begin to mature a little before the middle of August and by September 1st they are practically all gone.

A part of the first brood larvae do not complete their transformations at once after entering the soil but remain as larvae until the next spring, making but one generation a year for a part of the slugs. This was noticed by Professor Peck and later by Marlatt. It seems to be a provision for the preservation of the species. Should the second generation be wiped out by natural enemies, the slugs that are held over would still be left to propagate the species the next season.

THE EGG. The eggs are deposited in the leaf tissue of the various food plants—placed just beneath the upper epidermis and thrust through the leaf from below.

In the insectary eggs hatched in 10 to 14 days in the spring; average, 12.1 days; in summer in 7 to 13 days, average, 10.5 days.

Parthenogensis probably occurs with this insect, but this has not been satisfactorily proved. Many sawflies were examined, but no males were found. Eggs deposited by virgin females hatched, but all the larvae were weak, and none even reached the second stage.

THE LARVA. The newly hatched slug is about 1.2 mm. long, at first free from slime, but this is secreted in a few hours. The young slugs begin to eat out tiny patches in the epidermis; later they eat through the parenchyma to the lower epidermis, leaving the veins. One slug ate a space of 825.9 square millimeters during its lifetime, 19 days, according to a record kept by Mr. T. M. McCall, insectary assistant at the time.

After each molt, except the last, the larvae eat their cast skin, all of it but the head.

Five molts are probably normal. In 14 cases 5 larvae molted 5 times; 5, 6 times; 3, 7 times, and 1 larva molted 8 times, all under insectary conditions. Sometimes in successive molts the width of the cast head was exactly the same; often there was very little difference.

The average head widths of the stages were: Stage I, .35 mm.; II, .51 mm.; III, .67 mm.; IV, .85 mm.; V, 1.04 mm.; VI, 1.13 mm. The geometrical ratio between the successive head widths was practically .35.

Larvae matured in 13 to 26 days; average 19.4 days. No essential differences were noticed in the two generations of the time required; the same total length was found in either case. The time required for the separate stages was: I, 5 days; II, 3.2 days; III, 3.4 days; IV, 3.2 days; V, 4.7 days (average from both generations). Stage VI usually entered the soil immediately after molting.

Both Peck and Marlatt remarked that heavy rains are said to destroy the slugs. Professor Peck, however, said that he had seen the slugs retreat to the under sides of the leaves in a shower; a fact that we observed several times in the Iowa work. It seems quite likely that the supposed efficiency of heavy rains is really only the disappearance of the slugs to the lower sides of the leaves.

How the larvae reached the ground was a puzzle to us at first, but we found that they dropped down of their own accord. Occasionally orange-colored larvae were found on tree trunks, but they were not crawling down, but appeared to be going upward.

Finally some black cloth screens were placed on the ground under infested cherry trees and the larvae dropped readily to the cloth. They were most active about 4 o'clock in the afternoon. Eighteen larvae dropped to cloth screens between 2.15 and 4 p. m., June 29, according to notes made by Mr. T. M. McCall.

THE COCOON AND PUPA STAGE. The small earthen cells of the larvae were found commonly in the summer within an inch of the surface of the soil. Probably they go deeper for the winter.

In the summer it was about 20 days after the slugs entered the soil that the adults emerged. In 19 cases the average time was 19.9 days, with a range of 15 to 23 days.

THE ADULT. The sawflies were most numerous early in the morning, although they were found in small numbers at other times in the day. In July the sawflies all appeared at about the same time, but in the spring the emergence was spread over a much longer time.

NATURAL ENEMIES.

EGG PARASITES. The most common egg parasite was *Pentarthron minutum* Riley, kindly determined for me by Mr. A. A. Girault. It is a very tiny, yellow-brown species, which has often been reared from the eggs of a number of common insects.

At Ames this species was reared abundantly in 1909, but not at all in 1910. A few individuals were reared from eggs collected at Reinbeck, Iowa, in August, 1910.

From the first brood eggs the parasites emerged from June 28 to July 20; from the second brood eggs, from August 11 to August 20th.

The eggs affected by this parasite turn black, and of course fail to hatch. Two or three individuals were reared from a single egg.

Professor Peck in his original account mentions what is doubtless this same species and gives figures of it. After looking over the account I came to the conclusion that Peck had reared the same parasite in Massachusetts in 1798 that I reared in Iowa a hundred years later. Mr. A. A. Girault, to whom I referred a copy of this account, corroborated my opinion that Peck's parasites were most probably *Pentarthron minutum*.

The second egg parasite, *Closterocerus cinctipennis* Ashmead, also determined by Girault, was reared equally abundant in 1909 and 1910, from eggs collected at Ames. This species also affected both broods of eggs, emerging from first brood eggs June 28 to July 22, and from second brood eggs August 4 to August 21.

This parasite was always reared singly from the eggs. The black form of the parasitic pupa could often be distinguished within the parasitized eggs. It is presumably a primary parasite.

PREDACEOUS ENEMIES. In 1910 nymphs and adults of *Podisus maculiventris* Say were found to be very active against the slugs. Most frequently the slugs themselves were attacked, but the Podisus also captured the adults, according to observations made by Mr. T. M. McCall.

One Podisus nymph was kept 47 days in an insectary cage, during which time it ate 66 slugs; 1.4 slugs a day. The greatest activity was immediately after the insect became an adult, when it ate 6 and 7 slugs a day.

A species of Chrysopa and an undetermined Reduviid were also observed to prey on the slugs.

EXPERIMENTS WITH INSECTICIDES.

Paris green, 1 pound to 150 gallons of water, was effective. A home-made arsenate of lead, single strength, was not effective. Used against the older slugs this spray was very inefficient. I could not see that any slugs at all were killed by it. When used against the very young slugs, about half of them were killed.

A 10% solution of kerosene emulsion appeared to be quite effective.

Several simple soap solutions were found effective, at concentrated strengths. Whale oil soap, 1 pound in 2 gallons of water; Ivory soap, 1 bar in 2 gallons and White Laundry soap, 1 bar in 2 gallons of water, were all satisfactory treatments. These soap solutions may be quite convenient for use on a few cherry trees when the fruit is present.

DISCUSSION.

A MEMBER: I should like to ask if it is possible to use the spraying that is applied for curculio to kill the slug, or whether the slug works so late in the season that poison applied for the curculio would be washed from the leaves.

MR. WEBSTER: The spraying should be done about the middle of June in central Iowa. I am not familiar enough with the curculio to say whether this spraying would affect it or not.

A MEMBER: It would be too late to arrest the curculio.

DR. HOWARD: I regret that I did not hear all of the paper. I should like to ask about the affect of a strong stream of water on the slugs, without any insecticide at all.

MR. WEBSTER: I did not try that.

DR. HOWARD: In city yards a strong stream of water from a hose can be used to wash off the slugs. This method has been tried and given good results.

THE MECHANISM IN THE HATCHING OF THE WALKING STICK, DIAPHEROMERA FEMORATA SAY.

By HENRY P. SEVERIN, Ph. D., Professor of Zoology and Entomology, College of Hawaii, and HARRY C. SEVERIN, M. A., Professor of Entomology, South Dakota State College of Agriculture and Mechanic Arts.

(WITH PLATE XIV.)

In the Phasmidae, Mantidae, Blattidae and Acridiidae, the cervical ampulla is said to play an inportant role in the process of molting, and in some Orthoptera, also in the process of hatching. This ampulla, consisting of a soft membrane joining the head dorsally to the prothorax, can be transformed by the afflux of blood into a greatly swollen pouch, which then projects out immediately behind the head.

The process of hatching of various Orthoptera has been studied by a number of entomologists. Riley (7) does not mention the cervical ampulla while describing the phenomenon of hatching in the Rocky Mountain Locust, for he writes as follows: "The hatching consists of a continued series of undulating contractions and expansions of the several joints of the body, and with this motion there is slight but constant friction of the tips of the jaws and of the sharp tips of the hind tibial spines, as also of the tarsal claws of all the legs against the shell, which eventually weakens and finally gives away. It then easily splits up to the eyes or beyond, by the swelling of the head."

Packard (5) objects to Riley's account of the supposed action of the jaws and spines and believes that "the egg-shell is without doubt burst open by the puffing out or expansion of the membrane connecting the head and prothorax, just as the common house-fly or flesh-fly bursts off the end of its pupa-case by the puffing out of the front of the head."

Kunckel d'Herculais (3 and 4) gives the following account of the physiological mechanism in the hatching of the Acridiidae: "Les Acridiens rompent la coque de l'oeuf, * * * par la pression exercee a l'aide de la membrane unissant dorsalement la tête au prothorax que se transforme par afflux de sang en une ampoule cervicale."

In Diapheromera femorata the mechanism, which ruptures the various membranes and springs off the operculum when the walking-stick is about to emerge from the egg, cannot be observed in action on account of the hard, thick, opaque chorion. If the operculum is carefully removed from an egg shortly

before hatching, the embryo will be found with its head and prothorax situated directly beneath the portion of the egg removed (Fig. 1, *h* and *p*). The pressure exerted by the cervical ampulla is, therefore, directly against the operculum.

Hatching spines for the purpose of rupturing the embryonic envelopes and also for breaking or cutting open the egg-shell have been described from many insect eggs. Above the prothorax of Diapheromera, the thin amnion is covered by numerous long spines which point toward the operculum. These spines, like the egg-burster (or *ruptor ovi* as Riley (6) calls it) of Corydalus cornutus, are portions of the amnion itself. If the prothorax of a walking-stick is examined after its emergence from the egg, no spines are found, but simply short blunt protuberances. In all probability, the long spines of the amnion above the prothorax assist in rupturing the vitelline membrane which is especially thick beneath the operculum.

"When the young walking-stick is in the egg, ready to emerge, the meso- and metathorax are not remarkably elongate, but before the little creature is fairly out of its narrow prison, the thoracic segments assume their usual proportions. It is said to be a most curious sight by those who have observed this almost instantaneous development." (Caudell [2]).

An attempt was made by us to secure an explanation for this curious phenomenon observed by Caudell. After the chorion of the egg was removed, the embryo was found to be so curled up in the egg that the posterior end of the abdomen lay near the head region. A longitudinal section through the embryo showed that the thorax was folded transversely in a dorso-ventral direction (Fig. 2). In all probability it is simply the straightening out of these folds as the young walking-stick emerges, that causes the thoracic segments to assume their usual proportions. If the pressure exerted by the cervical ampulla at the time of hatching is not sufficient to rupture the amniotic and vitelline membranes and also to throw off the operculum, it may be possible that the straightening out of some of these thoracic folds assist in the process.

After pushing off the operculum, the young walking-stick, with the prothorax bent down at its union with the mesothorax, begins to emerge from the egg (Fig. 3). The cervical ampulla is now slightly swollen, and the prothorax possesses a deep green color, due to the blood which has accumulated within it.

The method employed during the process of emerging from the egg is almost identical with that which we (10) have described of a walking-stick withdrawing itself from its old skin during the process of ecdysis. A specimen examined under a binocular microscope during the process of emergence from the egg, will be seen to undergo a series of peristaltic-like movements of the segments of the body; these movements pass from the posterior end of the abdomen towards the head. With each series of these movements, the body is drawn out of the egg-shell a short distance, the legs also assisting somewhat in this process of extraction. At each pull of the legs in their attempted withdrawal from the egg-capsule, the strength of the pull is such, that the coxa of each leg presses against the body, causing in that region a temporary indentation. When the peristaltic-like movements reach the head, the walking-stick often raises the head vigorously upward in an attempt to withdraw the antennae.

The first part of the walking-stick to leave the egg is the dorsal surface of the prothorax (Fig. 3, *p*); then comes the head (Fig. 3, *h*), followed by the rest of the thorax. The antennae are freed next, and these may come forth either simultaneously or one soon followed by the other. The following order was often observed in the withdrawal of the legs: one middle leg was followed by the other; then the front legs were pulled out of the egg at the same time, and finally the hind legs. The abdomen does not leave the egg at any definite time in relation to the withdrawal of the other parts, but it may emerge after the antennae or, in other specimens, after the middle or front legs. The extrication of the antennae, legs and abdomen, however, does not always take place in the order just given, as is shown in the following table:

TABLE I.

Order of Withdrawal of the Antennae, Legs and Abdomen from the Eggs of Six Diapheromera femorata.

A	B	C	D	E	F
{antenna	antenna	antenna	middle leg	abdomen	abdomen
{antenna	antenna	antenna	antenna	{antenna	antenna
front leg	middle leg	abdomen	middle leg	{antenna	antenna
middle leg	abdomen	middle leg	antenna	middle leg	middle leg
middle leg	middle leg	middle leg	abdomen	front leg	middle leg
front leg	front leg	front leg	front leg	front leg	front leg
abdomen	front leg	front leg	front leg	{middle leg	front leg
{hind leg	{hind leg	hind leg	{hind leg	{hind leg	hind leg
{hind leg	{hind leg	hind leg	{hind leg	hind leg thrown off.	hind leg

Braces indicate that the two included appendages were extricated simultaneously.

Stockard (11) describes the hatching of Aplopus mayeri as follows: "When hatching the embryo's head and body come forth from the egg first, the antennae are then pulled out, the legs being the last parts liberated from the shell." The specimens noted under E and F in the above table agree with Stockard's observations on Aplopus, but both of these specimens had their appendages caught in the amniotic membrane (Fig. 4). In a previous paper we (9) have already called attention to the fact that dryness, at the time of hatching, has a marked effect upon the emergence of the walking-stick from the egg. With the addition of water which was added drop by drop to the egg-shell, within which the above-mentioned specimens were caught, these walking-sticks succeeded in freeing themselves.

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EXPLANATION OF PLATE XIV.

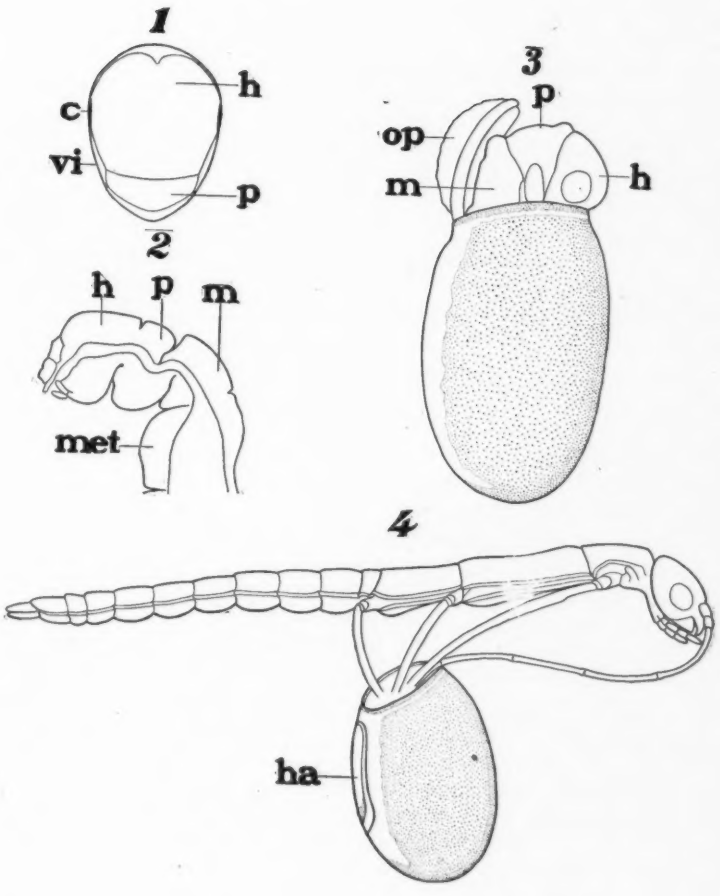
All figures were drawn with a camera lucida.

FIG. 1. View of embryo after the operculum has been removed showing the head and prothorax directly beneath. The pressure exerted by the cervical ampulla, which joins the head dorsally to the prothorax, would be directly against the operculum: *h*, head; *p*, prothorax; *vi*, vitelline membrane; *c*, compound eyes.

FIG. 2. Longitudinal section through the head and thorax of the embryo, showing the transverse folding of the thorax in a dorso-ventral direction; *h*, head; *p*, prothorax; *m*, mesothorax; *met*, metathorax.

FIG. 3. Walking-stick emerging from the egg, showing that the prothorax is bent down at its union with the mesothorax: *h*, head; *p*, prothorax; *m*, mesothorax; *op*, operculum still adhering to the egg by means of the so-called "shell membrane."

FIG. 4. Walking-stick with its appendages caught within the egg-shell: *ha*, "hilar area."



H. H. P. and H. C. Severin

SOME SUGGESTED RULES TO GOVERN ENTOMOLOGICAL PUBLICATIONS.

By T. D. A. Cockerell.

Many years ago in England, I captured a rather uncommon hemipterous insect, and sent a record of it to a well-known entomological journal. The editor, being a lepidopterist, had never heard of the bug, but did know of a very rare moth having the specific name (*bicolor*) employed. He accordingly changed the generic name to that of the moth, and I found myself the astonished recorder of an insect I had never seen alive, nor hoped to see. More recently I communicated to a publication in this country a short paper on a supposed new plant of the genus *Ribes*. The editor, not liking the title, substituted "A New Currant from Arizona," whereas the plant was a gooseberry, and was from New Mexico. These rather amusing instances are cited merely to illustrate the indisputable fact that it is risky for an editor to interfere with the contributions he publishes. On the other hand, I have been shown manuscripts sent in for publication which, if printed exactly as received, would be simply unintelligible. The editor is in a difficult position, and as a rule, I think the contributors have little reason to feel otherwise than grateful for the treatment they receive; it is at least not rarely better than they deserve.

Although I am against editorial alterations in manuscripts, I think it may be entirely proper to adopt some simple rules to be enforced in every case, the papers which fail to conform being returned to their authors for correction. As entomological editors appear to have no such rules, with the exception of a few relating to typography, it occurs to me that the Entomological Society might properly discuss and adopt a set, pressing them upon the attention of editors with such authority as it may be considered to possess. As the result of a little private correspondence, I believe it would be easier to get all the editors together to agree upon certain things, than to persuade them individually to take the desired step. I cannot do more than present a suggestive outline, which may be discussed and amended as necessary.

(1) When a new genus is described, the type species must be stated; it may be as well to add, that the binomial made by combining the generic name with the specific name of the type species must be printed.

(2) No new genus will be published, that is not based on a described species.

(3) Rules 1 and 2 also apply to subgenera.

(4) No new species may be described without comparing it with some other described species, or stating wherein it differs from other members of the genus.

(5) When a new species is based on specimens from several localities, it must be explicitly stated which is the type locality.

(6) When a new species is described the data concerning localities and collectors must be given in full so far as known. This is also strongly recommended in the case of all new records. If the locality, collector, etc., are not known, it may be well to say so, although this may be taken for granted if the writer is known to be careful in citing data.

(7) It is impossible to avoid all errors in spelling, grammar, etc., but so many of them have appeared in recent years, that American entomologists have some reason to feel ashamed. It would be easy to compile a list of scientific names which must be retained in our lists, although faulty to the extent of being offensive. This is true in spite of the freest recognition of the fact that scientific latin is a living and growing language, and must include many words unknown to the ancients. No rule can cover this difficulty, but it might be worth while to collect every year a list of these criticisable productions, and set them forth as a warning to authors and editors alike.

(8) It is not permitted to publish new varieties as binomials; the trinomial must in every case be written out.

THE COMPOSITION OF TAXONOMIC PAPERS.

By Richard A. Muttkowski.

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Taxonomy is the most important incident of Science—things must be named before we can write of them. If we consider the proportion of zoological papers at the present time, we find that about two thirds are systematic. But this proportion increases to seven-eighths if entomological papers alone are considered.

In taxonomy we usually speak of only two types of contributions: (*a*) text books, prepared for a mixed public, and (*b*) original work, which is intended for the entire scientific world, but whose chief appeal is directed to a small group of contributors. These form a special class, distinct in conception and treatment from other scientific papers.

The style of composition proper in a morphological, ontogenetical or phylogenetical paper would be found impracticable in a taxonomic paper. Yet, while the greater number of entomological papers are taxonomic, it nevertheless remains a curious fact that as yet no compendium for taxonomic composition has been published.

For papers other than taxonomic we have Dr. T. Clifford Albutt's excellent book, "Notes on the Composition of Scientific Papers" (MacMillan Co., New York, 1904, 8vo). While many of the chapters of this work would be of interest to systematists, they do not pertain directly to taxonomy; the volume, on the whole covers a quite different ground, that of scientific theses.

To say that nothing at all has been published on the present issues would invite criticism. On the contrary, I have found copious and more than sufficient material in the more prominent journals of the past two decades. But these contributions are widely scattered; moreover, they are written as protests and usually deal with a single topic only. While I cannot lay claim to originality in the suggestions included in this paper, I have endeavored to treat all of the more vital topics bound up with taxonomy; aiming to suggest such standards in writing as would conform to the various needs of those interested.

Briefly stated, a standard is the result of an average or consensus of opinions upon a given subject, hence a criterion. Thus far the only criterion of any worker has been the approval of his fellow-workers along the special line of work he has adopted. This basis is hardly sufficient, as not a small coterie of workers but the world at large is intended to be benefited.

It must be remembered that this paper does not treat of criterions of species, but with the composition of descriptions and general methods of presentation. That these are perfect and above reproach probably none will maintain.

I have talked over these matters repeatedly with scientific workers. Curious to say, dissatisfaction with present methods and with the absence of definite standards was prevalent everywhere. The necessity of co-operation toward the achievement of practical standards was sometimes very strongly expressed. A digest of all these opinions, private or published, may be summed up in the following: Better methods of description are desirable; the nomenclature of species and genera, of colors and types to be regulated; titles of articles to be made more comprehensive; reprints to contain place, time and name of publication, etc.

I. Standards for Descriptions.

A. Specific Description.—J——— s———, an unencumbered species: Front pale, palpi scaled, thorax with black stripes, antennae yellowish, abdomen spotted, legs with pale, wings with black markings. Head with short pile, abdomen tufted, a small tuft between the antennae, which are fuscous at the base, white toward the tips. Wings white, with four or seven black lines crossing them, the lines curved or straight. Abdomen with tufts black, exceeding anal angle. Legs long, with spurs. Palpi reaching the vertex, legs slightly darker at the joints.

I dare say, that no living man could determine a specimen from this extravaganza. Yet the description is made from an actual species—*Conchylodes platinalis*, Lepidoptera–Pyralidae.

Furthermore, it is typical of many descriptions of the past, and, I regret to say, of too many in the present days.

It is curious how little logic is often applied in formulating a description. One specialist, who has written hundreds of descriptions, seems to have found particular pride in making these as intricate and involved as possible; there is no logical sequence in the treatment of the main divisions; on the contrary, the acrobatic description jumps from antennae to legs, from abdomen to head, wings to palpi, venation to tarsi, morphological characters to vestiture, color to structure, etc., etc. So much so, that after comparison is completed one must begin over again, as it is impossible to remember the way through the labyrinth.

Descriptions should not be written for personal aggrandizement, but to announce a new fact or discovery to the scientific world. Such being the case, the description, once published, belongs to the world at large and no longer to the writer. The author therefore owes it to science that the facts of which the world is to become owner be presented in a manner most accessible to, and best applicable by other men. If the author for any reason whatsoever is careless and inaccurate he sins against science. After all, there is an intellectual as well as a moral conscience.

"Head pale, eyes small, dark, vestitute smooth and yellowish, body moderate, legs short, tibiae stout," applies equally well to Mr. Jones as to *Pediculus capitis* strolling on his head. Brevity may be the point of wit, but science is no joke; taxonomy deals with facts, not idiosyncracies. Who has not felt the bane of two to eight lined descriptions, any one of which harmonizes easily with half a dozen or more distinct species? I do not believe that an entomologist lives who has not at one time or other execrated these brief, vacillating descriptions. But why do entomologists continually write others that are no whit better or longer? Let it be known, that one thorough description covering three pages may be of more use and more valuable to science than three descriptions on one page. One may suggest that the perusal of brief descriptions saves time; but when we come to analytic comparison of closely related species the brief description forms an obstacle which results in considerable loss of time. What of genera whose species are extremely variable? Can the extent of specific variation together with a description of the aver-

age be summarized in twenty lines? Hardly. The ideal description will be a careful analysis of all body parts with all their appendages, attributes and characteristics, to be followed by a summary of salient characters of the type and a comparison to related species. I maintain that this cannot be accomplished on less than a page.

It is terrifying and discouraging to be confronted by a page of solid description, where all characters, whether head, thorax, abdomen, or wings, flow together in a solid phalanx, so that it is impossible to pick out readily any special point desired. Descriptions should be paragraphed or captioned. This costs no extra labor, and, in fact, presents a much neater appearance when published than the solid, uniform mass of words. Besides it affords greater facility to the student who wishes to look up certain characters for comparison.

Again, a description should not be isolated. I mean, comparison to related species and indication of the position of the new species should follow the description. It is reprehensible negligence to describe a new species from a genus already containing a dozen or more species and to omit all mention of either relations or position; such proceeding is indeed worthy of reprimand. To say the least, the work of the author will be placed in an extremely doubtful light. The thought suggests itself, that the author himself was ignorant of the relations and that he described a species at hap-hazard.

After all this, why pay any attention to identity, number, and custody of types? Why state the locality from which the types came? Why select a holotype from a series of twenty specimens that show considerable variation? No one is ever expected to express any doubt of the scientific determination of the twenty. No one is ever expected to feel interested in looking up the types for comparison or study after having become familiar with the all-sufficient description of ten lines. This seems to be the opinion of some taxonomists. For they very carefully avoid all mention of the number of types, their identity (see nomenclature of types) and only grudgingly designate the locality from which the types came by the remarkably precise state name. The latter, it is supposed, will give the reader all the ethological information he desires; so that if he wishes to capture specimens of the same species, all he need do is to pack his trunks and hie himself to "Texas" or "Nevada" and pick the species from the

mountain-sides and valleys, from water and land, from trees and grass, or just open his bottles to stop their fall from the heavens. It must be there, for the author said so; he said "Nevada" and this is Nevada.

The following is a scheme for an accessible description:

J—— s——. Not a new species:

1. (a) Sex, usually ♂, and dominant color; size.
   (b) Head: mouthparts, face, eyes, vertex, antennae, occiput, etc.; vestiture, colors, structure, etc.
   (c) Thorax: prothorax, mesothorax, metathorax, structure, vestiture, colors. Legs, their color, structure, vestiture and appendages; etc.
   (d) Abdomen: structure, markings, color, vestiture, appendages, etc.
   (e) Wings: color, markings, vestitute, venation, etc.
2. (a) ♀ and dominant color; size.
   (b, c, d, e) as above. Difference from ♂.
3. Summary of salient characters. Unique characters. Variation.
4. Comparison to related species, position of species.
5. Material: Types, identity (see nomenclature) of types, exact date and locality of capture. How (ethology) and by whom captured.

Of course, this scheme cannot be strictly adhered to in the different orders; it is, however, sufficiently elastic to permit the changes required. What is important in one order, is negligible in another. But the fundamental idea of setting forth by paragraphs or captions the principal parts of a description in successive order, will no doubt be understood.

B. Redescription.—How a redescription should be formed depends on the original description. If the original was carefully drawn, the other may be a summary of the first with possible new points of variation, etc., discovered. Or if, as very often is the case, the original was insufficient, the redescription should be carefully formed; in fact, the author should aim to replace the first with the second description. Even though his name stand not as the sponsor of the species, the task of redescribing is not a thankless one, as need hardly be explained.

Redescriptions are also written for convenience, either as summarizing the knowledge of the species, or, as indeed commendable, to place an otherwise inaccessible description within the reach of the student. Much of what has been said under the preceding caption applies here also and needs no repetition.

C. Generic description.—What is a genus? A classificatory group of plants or animals, embracing one or more species; the primary condition of binary nomenclature; a uninominal used for the lowest phase of the grouping of living forms accepted by naturalists.

What constitutes a genus? A single species or several that, aside of specific differences, have certain morphological features in common, which distinguish them from all other groups of species.

When is a genus valid? When so stated by the sponsor, the nomenclator having noted certain morphological characters, the value of which is recognized by fellow-workers, and who accept this diagnosis upon the given characters; when placed with a monomial (specific) to signify that the species possesses certain distinguishing group characters.

As genera constitute the lowest, but at the same time the most important, phase of grouping, at least some attention should be given to the formation of generic descriptions; especially so in larger contributions, such as monographs and generic summaries and synopses. Generic description is allied to specific description; hence methods ought to be similar.

Some of the essentials of a generic description are the following:

1. That the type species be cited. It should be noted that the type species must be a species then or previously described; else we have merely a nude name.
2. That the characters on which the species is based be given. Although the generic name alone, when coupled with a described species, is recognized as valid by the codes, the systematist will insist that the absence of a generic description is an unfair apprisal on the part of the nomenclator.
3. That these characters be stated concisely; that is, write to the point. Brevity is not conciseness. One may be brief and vague at the same time.
4. That these characters be stated in orderly manner. Especially in larger papers unity of methods is advantageous. If one description begins with the legs, another with head, a third with the venation, etc., study is made difficult. Uniformity of methods facilitates study and progress.
5. That other species belonging to the new genus be listed. While this necessitates thorough study on the part of the nomenclator, it really is his duty. To split up large genera upon characters drawn from a single species is a simple matter. But the nomenclator should verify the stability of his characters by extensive comparison with related species.
6. That other genera be compared, or, at least, the position of the new genus indicated. To describe a new genus of a family already containing twenty or thirty genera and not indicate the position or relations of the newcomer, is not scientific; it denotes carelessness or ignorance.

Not exactly essential, but still of value in extended papers are the following:

7. The etymology of a new name should be explained. This often gives a clue to a character or to the relation of a genus.

8. The distribution of a genus should be cited; namely, whether it is Oriental, Palearctic, Nearctic, etc.

9. The order and family of the genus should be indicated in title or text. This pertains especially to brief papers. As nobody can be familiar with the specialties of all authors or with all generic and family names, this offers an aid in the study and classification of papers.

10. The validity of the generic name should be considered by the author. It is the author's province to do so in the first place. If taxonomists cared to put a little time or expense to the verification of a name, there would be fewer homonymns coined each year.

II. Standards for Colors.

Of all standards these are most needed, since they are most sinned against. That no color standard should exist in a division of zoology, which is of prime importance economically as well as numerically, and where frequently colors are our only tangible guides—unfortunately so—for generic and specific determination, is hardly conceivable. Yet such is the case. After one and a half centuries of entomology, in which the number of described species has been advanced from a few hundred to several hundred thousands, we are utterly lacking of any color standard and are guided in our nomenclature of colors solely by the individual impressions of the taxonomist. That such a basis is absolutely at fault, needs no special asseveration.

The perceptions of most men in regard to colors are extremely crude. (To anyone who may doubt this statement I advise a visit to some artist. One may state to him his impressions of ten different shades of color; and observe then, how often the shade will be misnamed by the amateur as against the professional testimony of the artist. I do not claim a better perception than other men and am found at fault equally as much as others.) In their school days men were taught the tale of three to seven primary colors, and a small trifle of the shades resulting from combinations of the primaries. A little of this they remember through the rest of their lives. And, strange to say, when a man would not use a term or expression to designate an anatomical detail unless he is absolutely certain that it is correct, this same man will unhesitatingly designate colors, when, to say the

least, there is good reason to doubt his exact knowledge of the particular color. I do not say that this is intentional; it results from overconfidence of his particular knowledge. This carelessness arises from the lack of proper standards. Accordingly men are forced to formulate their own standards, which are necessarily at fault It is only through an average or consensus of opinions that standards are reached.

In a desire to be conscientious men often circumscribe a condition when they find their exact knowledge of colors inadequate. This is usually done by the addition of such terms as "pale, light, medium, shining, glabrous, bright, vivid, dark, dull," etc., to the primary color. While this effort is commendable, it offers no more certainly than the mere citation of the primary shade; and the interpretation of the circumscriptive adjective is frequently very liberal.

Probably the most liberty has been taken with the term "fuscous" in our descriptions. This term has been made to designate any darker shading on a light back-ground, beginning with a tinge of the palest yellow against a white or translucent base to a seal or clove brown against any lighter background. "Orange," "yellow," and "green" are others of these liberally interpreted colors. The heart-rending or laughable (as one views it) puzzling of students, who are familiar with exact anatomy but not with the vagaries of taxonomy, when attempting to determine a species from description and to seek conformity between the colors as given by the author and the specimen in hand, affords too well known illustration.

Viewing the matter from the stand-point of my own desultory experiences, the question occurs to me: If at the present time, when the approximate number of described insects amounts to about 300,000 species, identification is difficult, the determination often exhausting the patience of the taxonomist in the vain endeavor to divine the protologist's perceptions of colors; further, this difficulty having encumbered taxonomy with labyrinthine synonymy;--what, then, will be the condition of taxonomy fifty years hence, if we continue with present methods, when species will have increased to approximately 1,000,000?

Happily there is a tendency among our eminent specialists in the last decade to standardize their descriptions as far as colors are concerned. (This is beautifully instanced by Packard in

his later works, such as his monograph of the Lepidopterous family *Notodontidae*). Yet these are so few that their number may be regarded as negligible. That the necessity of color standardization is imperative and that this is well recognized is shown by Dr. J. B. Smith's addition of a plate of colors to his recent "Dictionary of Entomological Terms."

Structural (iridescent) colors are sometimes difficult to define because of the varying hue, according to the angle of refraction and reflection. Yet with reliable color charts these difficulties would be obviated.

Frequently the belief asserts itself that specimens were described in lamp-light. How unsatisfactory and misleading artificial light is taxonomists ought to know only too well. The simple experiment of exposing green, yellow and brown insects, notably shining specimens, successively to gas, electric, acetylene, candle, kerosene and the natural sun-light yields some surprising results.

A color standard need not be an assortment of infinitesimal shadings, gradings, and combinations of the primaries. A representative selection of from thirty to fifty colors is sufficient for all practical purposes.

The fact that detailed comparison of the colors of a specimen to color charts entails some extra labor should not deter taxonomists from making these comparisons. The appreciation and gratitude of their fellow-workers as well as of their followers will be their reward. The dominant color should be stated in all cases. True, the colors of dead insects are rarely quite the same as in life, or those of younger insects the same as those of mature specimens. Yet the fact that colors have faded in death, or that they change with age, is of secondary importance. A description is not based on possibilities, but on tangible concrete actualities. These alone should rule. If there are good reasons for assuming that the colors of the specimen are not representative, this can, and, in fact, should be stated. Having a dominant color as a basis, it is comparatively simple to fix the position, extent, and shade of the other colors an insect may exhibit from further comparison to charts.

The terminology of colors may be somewhat cumbersome. But science is not "belle lettres"; the taxonomist does not consider whether the sentences he reads are syntactically correct or rhetorically rounded, but judges from their contents as to

their value. At that, why a composite terminology? Why not a restricted nomenclature based on a few names with divisions indicated by subnumerals, as red 1, red 2, red 3, etc.. blue 1, blue 2, etc., etc.?

Good works on colors exist, notably Ridgeway's Nomenclature of Colors, as adopted by Ornithologists. (Unfortunately this excellent work is long out of print, and because of its limited edition it is now practically impossible to purchase a copy in the book-market). But for practical purposes a simple chart, as that hand-painted by Frederick Oughton (London), if selected by a representative commission of entomologists, could be manufactured at low expense, which would be easily justified by the demand. This would offer a standard for all times, not to mention the other obvious advantages resulting thereby.

III. Standards of Nomenclature.

A. Generic and Specific Nomenclature.—This is the only sphere where standards already exist. These standards are the codes of zoological nomenclature, such as the International Code of Zoological Nomenclature, the A. O. U. Code of Nomenclature, etc., which are commonly followed by zoologists. If I say "followed by zoologists," the phrase must be given the most general and generous interpretation. Speaking of a class I can say "commonly"; but when speaking of groups of specialists—to say it mildly, many groups use the nomenclature of 1810 instead of 1910. This sounds anomalous, but it is not. For the regulation of nomenclature by codes of universal sanction is comparatively recent, and the commissions are only gradually bringing order into the nomenclatural chaos that existed before their day.

One cannot expect, I suppose, that a specialist on the biological phase of insects should be interested in the "arbitrary, dry" codes of nomenclature. Yet it must be remembered, that taxonomists alone have caused the chaos. Taxonomy is "arbitrary" also. What one man considers a variety, another calls a distinct species; and still another refuses to recognize either opinion. Or are "splitters" and "lumpers" only births of fancy, or memories of the distant past?

The aims of the codes of nomenclature are to make the nomenclature as free and unencumbered as possible. Hence the rules set down for guidance. If taxonomists disdain, or even refuse, to follow these rules, who else should follow them?

B. Anatomical (Morphological) Nomenclature.—Standards for generic and specific nomenclature have been noted. The present issue is of equal significance.

The chief objection that may be stated on this question is indefiniteness. A lesser offense is the scope of the terms; *e. g.*, while by "front" the author may intend to include nasus, epistoma, rhinarium, labium, etc., we, however, know that front means *frons* in the scientific interpretation and nothing else. What the author thinks, we cannot telepathically or by any other means divine.

Each business has its technical nomenclature. No hardware man will hand you a shingling-hammer when you ask for a claw-hammer. To the business man the two terms signify two different things and he will never be so careless as to use the one for the other. Yet among taxonomists we find a continual interchange of terms, such as joint for segment, tarsi for tarsal claws, mouth for labrum or mandibles, abdomen for venter, etc.

When a taxonomist writes "face yellow, abdomen spotted," it is supposed, that he knows what he means. But unfortunately I do not. A specialist, who knows the peculiarities of the score or twenty-five other men working on the same branch of science, will possibly understand what is meant. Not so the individual who attempts to determine a species, less because of special interest, but because of some observation he made on it and which he desires to record in his book of field-notes.

Another idiosyncracy is to use comparative terms for the length or size of any portion of the body, as, for example, "front as wide as the eyes, elytra twice the width of the pronotum, tarsi about two thirds the length of the tibiae, etc." This mode of measurement is miserably uncertain; miserably, because of the misery of the student who attempts to make the same comparisons and cannot see them as the author saw them.

How many men are able to mark the exact middle of a line at a glance? Aside of usual differences in refraction in two eyes, some aberration will be caused by the strain of focusing to the same point. A "mathematical" eye is a virtue that very few people possess. Still more difficult is to find the exact third of a line. What then of paralleling lines, or approaching lines? What of curved lines, irregular lines, etc.? Or is the chapter on "Optical Illusions" as taught in Physics only an illusion?

Bad as color illusions are, mathematical illusions are worse. The chapter on "Optics" ought to form the favorite reading of many taxonomists. A difference of one millimeter on an insect of 20 mm. length is slight; but it makes a considerable difference on an insect of 8 mm. It is a peculair experience to read in a description of a beetle or any other insect "elytra twice the width of the pronotum" and then find by actual measurement that the pronotum is 4 mm. at its widest point while the elytra are 10 mm. or more in length. Similarly with most other comparative measurements. When tested by the micrometer or millimeter scale they will be found considerably aberrant. Hence the urgent advisability to introduce exact measurements instead of the unreliable optical method of comparison.

One standard does exist in anatomical nomenclature, namely the Comstock-Needham nomenclature of wing venation. The merits of this system are undisputed and recognized by all modern systematists. But instead of unreservedly adopting a system the value of which they confirm, taxonomists intermingle the antiquated miscellaneous wing nomenclature with the logical modern terminology. As a result we are continually thrown from one style of naming the veins to the other. This may not be troublesome for the specialist. But if a student is generally interested in entomology, he finds himself in a constant quandary as to the special terminology of each particular order, as they are easily confused; whereas the Comstock-Needham nomenclature was especially designed to obviate this difficulty. It is true, certain orders have certain appendages which it is desirable to retain, *e. g.*, for Neuroptera the thyridium cell and end-forks, bees the subcostal cells, etc. These should be retained, as they are special attributes of the respective order, family or genus. But the fundamental principles of venation, as outlined by the Comstock-Needham nomenclature, are possessed by all orders, viz., costa, subcosta, radius, media, cubitus and anal vein. Why not use them instead of vein 1, 2, 3, 6, 8, 10, etc.? The terminology is simpler, it is less aggravating, it is more logical, and it is an aid to the student and worker.

C. Nomenclature of Types.—Quite as important as specific and anatomical nomenclature is the nomenclature of types. Considerable attention has been given to the latter study in recent years. As the various departments of natural history are dependent mainly upon descriptions for the taxonomic

knowledge of specimens, the types of these descriptions grow in importance as the sum of our knowledge of species increases. The best description is not perfect, but, more often than not, deficient in some important taxonomic character. Hence the need of later systematists to refer to the type as the absolute standard of comparison. A nomenclature of types has accordingly been developed in recent years which is given the same importance as that which taxonomists attach to species nomenclature. While less diversified than the latter, it should become of equal interest to the taxonomist, as it remains for him to apply it.

With the close of the year 1906 we have a series of five primary types and four supplementary types designed to meet the needs of both systematist and type custodian. Some of these designations will possibly be disregarded or even found insufficient; this depends upon the individual, whether he be "splitter" or "lumper."

The first step toward a logical nomenclature of types was made when taxonomists began to set aside one of a series of specimens as the type proper, and to name the remaining specimens cotypes. Too often it had been found that a series which the protologist defined as one species actually represented two or more species. Hence the advisability of naming only one specimen the type and the others differently. The name "cotype", although used so universally, is in such case a misnomer and was finally set aside for the more pertinent and exact "paratype"—to signify specimens of the original series other than the type specimen. As the word "type" is subject to many interpretations according to the combination in which it is used, Schuchert in 1897 devised the word "holotype"—meaning "sole type"—for the single specimen on which a description should be based. The name "cotype", however, was not discarded; its applicability only was limited. "Cotype", in its present interpretation, is properly applicable only in paleontology; for instance, when we have a fossil and its reverse. Another instance, from zoology, would be the following: two flies caught in coitu and not separated in death. If mounted together neither male not female can be called holotype; there is no necessity of singling out one of the specimens, as there can be no doubt of the two belonging together.

The following is a summary of type nomenclature:

A. Primary Types.

1. Holotype (**H. T.**)—A single specimen, or one selected of a series.
2. Allotype (**A. T.**)—A single specimen of the sex not designated by the holotype.
3. Cotype (**S. T.**)—Specimens of the original series when there is no holotype (=syntype).
4. Paratype (**P. T.**)—Specimens of original series when there is a holotype.
5. Morphotype (**M. T.**)—A single specimen of the second form described of a dimorphic sex.
6. Lectotype (**L. T.**)—A cotype chosen after publication as holotype.
7. Chirotype (**X. T.**)—Specimen on which a manuscript name is based.

B. Supplementary Types.

1. Plesiotype (**P. t.**)—Material on which subsequent descriptions or figures are based (=apotype and hypotype).
2. Neotype (**N. t.**)—A specimen from the same locality as the original type described or figured when the original type is lost.
3. Heautotype (**H. t.**)—Specimen identified by the nomenclator or used by him for illustration, but not belonging to original series. (=autotype).
4. Plastotype (p. t.)—Plastic reproductions from type specimens. These must be casts. Models not included.

The five prior names (1, 3, 4, 6, 7) for primary types are sufficiently simple and certainly not cumbersome for the systematist. Yet it appears to me that one condition quite as important as the holotype has been overlooked; also a second one, which, if not general, still applies to certain orders of insects.

The first of these is easily apparent, Very many descriptions are based on one sex alone; often several decades pass before the unknown sex is discovered and described. Since this description is of primary interest to taxonomists, the specimen on which this description is based in my estimation also merits a type name; and, what is more, should be classed among the primary types with the holotype. The second case is sexdimorphism, common in a few orders of insects, rare in others, but still of such frequent occurrence that a type name for the dimorphic individual appears advisable. To designate these cases properly I have elsewhere (Bull. Milwaukee Museum, Vol. I, page 10, 1910) suggested the terms "allotype"—the other—for the unknown sex, and "morphotype"—form—for the dimorphic form of a sex.

Allotype designates the sex not represented by the holotype. The allotype need not be described by the protologist (first describer); it can be contained in the original as well as in any subsequent description by other authors. Thus, if the protolog describes only a holotype male, the first female subsequently described is to be called the allotype; and vice versa. Morphotype applies only to the second form of a dimorphic sex. Here also the date when and the author by whom described are immaterial. (As the first form of a dimorphic sex will be represented in the holotype or allotype, there may be some doubt as to the advisability of classing morphotypes among primary types. However, as both forms of a dimorphic sex are of equal importance to taxonomists I have placed morphotype in a position similar to the holotype and allotype.)

Thus far few others than cataloguers have made use of the type-terminology here outlined. In fact, most of the terms were originated by them, since the thorough acquaintance with their subject gained by the compilation of catalogues has made them more susceptible to the various needs of taxonomy. As all of these terms are broad and permit of great latitude in interpretation and application, the systematist ought not hesitate to apply them. Past laxity in the treatment of types, and also in their preservation, has resulted in infinite confusion and has helped to increase synonymy beyond all reasonable bounds, so that in some orders the synonyms average 1.5 to each valid species.

IV. Standards for Keys (Tables) of Genera and Species.

1. ♂ with appendage to hind tibia.....2
   ♂ without appendage.....4
2. ♀ with abdomen tufted.....3
   ♀ with abdomen untufted.....Kilimanjaro
3. Vein 6 usually curved in ♂, ♀ variable.....Popocatepetl
   Vein 6 usually straight .....Aconcagua
4. ♀ with abdomen untufted.....5
   ♀ with abdomen tufted .....Matterhorn
5. Vein 6 curved .....Elias
   Vein 6 curved at end in ♂.....Everest

I defy anybody to reduce a specimen to its proper genus with a key of the foregoing type. Unfortunately, only too many of that sort exist and new ones are continually fashioned.

A genus is the primary condition of taxonomy, and the use of secondary sexual characters for generic definition is an outrage; an offense, which should not be condoned. Some of the

best taxonomists have placed their work in a questionable light by means of unsatisfactory tables like that given above. The only recourse in such cases is the original description, which is by no means such a simple proceeding as would appear on the face of it, as it often means a long, tedious search through many volumes.

One may call the aid of the extended generic description, but the purpose of the key is to summarize what differences exist between genera. Tables are meant to be short-cuts through taxonomy; but I might as well try to run an engine on a railway which has one track alternately on each side of the ties, as determine a specimen from many generic tables. The use of geographical names in the key above is pertinent. It is just as difficult to climb those mountains as to determine specimens from some keys. Tables of the style outlined cause loss of time, besides loss of temper. We are all human; and a scientist is not always the "dry, imperturbable fossil" the joke-antiquarians would have us believe.

Among species tables we see many of similar nature. Yet here vagueness is excusable, while for an unsatisfactory genus table no valid excuses can be made. If the relations between two genera become too intimate, if distinctions fail—then the genera merge.

Sexual characters are often the only ones that can be reliably applied in specific keys, and their use will be questioned by no one familiar with the difficulties of specific determination. Errors are possible everywhere, but they are offset by good work in other parts of the paper. Most often they result from a misconception of the specific value of certain characters. The aim, however, to compile a table of practical value will be easily apparent.

Many of the difficulties of specific keys could be obviated by more care in the explanation of the essential characters used, their individuality, their variation, and their relation to others. But is there an excuse for the use of such terms as "larger species," "smaller species," "more slender," "more robust," and the like, in tables without in any way defining the limits of the terms? It is with feelings diametrically opposed to pleasure that I plod through a table of, say, 25 species, along lines indicated by "larger species," and "smaller species." What does the author mean thereby, I wonder? At which

size does he draw the line? My specimen is of moderate size and might be referred to either group. Therefore, is bulk the author's criterion? Or is length? Or width? Or odor?

There are plenty of good, workable tables that will serve as models. An ideal table that would permit of "hard and fast" lines of division for species is, of course, impossible. But much could be done toward improvement by the elimination of indefinite terms from specific tables and sexual characters from generic tables.

V. Standards for Indices.

Indices are the bane of scientific works. While their purpose is to facilitate reference to, and study of the contents of a volume, it is rarely, indeed, that they achieve their purpose, because of their general insufficiency. Beginning with ordinary check-lists, bibliographies, travels, monographs, etc, taxonomic works are most often poorly equipped as regards indices.

It is impossible for any man to know all the species and genera of the average order. It is a fact, however, that just those publications which are greatest in volume and importance (taxonomical, ethological and otherwise) are the most poorly indexed. Some authors cite only genera in the index. Others feel that such method is insufficient and append the names of the species under the genera. While that is an improvement, it offers little aid to the student not familiar with the particular order.

In this age of books, when it is possible to distinguish genera, species, synonyms, etc., each by various styles, sizes and impressions of types, the antiquated system of indices, as above referred to, seems inconceivable. The trouble lies—so it seems to me—in the fact that authors seem to confound the index with a table of contents.

To quote, "an index is a pilot through strange seas of thought. A book without an index is like a ship without a rudder." Continuing the simile—a book of entomology with generic index only is like an ocean-steamer with a canoe-rudder; and an index with the species names under the genera is like a ship with the rudder at its side.

I need hardly assert that it is those books which are freely and carefully indexed that are most referred to. I feel much as the gentleman who said to me: "A scientific writer who does not care to make a complete and usable index to his works,

should be prevented from writing at all! At the bottom of every insufficient index is not carelessness, but downright laziness!"

To set the standard for indices is not very difficult; but the standard varies with the contents of books and papers. Here is the criterion: Since the aim of an index is to make the contents of a volume accessible to the reader, it should be so constructed that it will permit access to the greatest possible number of references in the least possible time. In other words an index is a medium of saving time. Hence an index should not be merely a carelessly jumbled summary of the contents, but a carefully arranged alphabetic list of all names, facts and captions in the volume. This includes technical as well as popular names, generic as well as specific names.

There is such a thing as over-indexing. The author must use his judgment as to the amount of detail he desires to index. Also, unnecessary repetition should be avoided. One fact, however, is patent; that if the author wishes to see his work considered at all as a work of reference, he must supply it with a good index. I, for one, do not care to use poorly indexed books, and consult such as rarely as possible. To say the truth, I consider it a personal affront, when upon purchasing a book, I find myself maltreated to several hundred pages of facts and names, and a two-page index. The author has no cause to treat his readers as if their brains were ware-houses; that they need but read his book and file away the contents together with the exact page number, etc., for future reference. By purchasing and reading a book I am doing the author a twofold service. And if I remember some of the statements and quote the book as an authority, the acme of the author's expectations is then reached. More he has no right to demand. But a starved index is inimical to progress, since few men will care to quote when they are unable to find the passages from an insufficient index.

When is an index desirable? One friend has stated this succinctly: "Any taxonomic paper citing more than fifty names should have an index of its own." This seems reasonable to me. An index of fifty names, run in two columns, eight point on a ten point base, would occupy less than the ordinary four by seven page of our journals. Because of the practice of societies and institutions to send reprints to an author for pri-

vate distribution, this special index seems more than justified; unless the author expects his associates to supply the index privately. But this is expecting too much. Take, for instance, some of our well-known entomologists, who receive hundreds of reprints in a year, among them contributions exceeding 100 pages. It is astonishing, how few of these larger papers are supplied with an index at all; at that, the indices are mostly of the Spartan type. Should these men undertake the necessary clerical work and compile the missing indices? True, many of these men keep card-indices of their specialties. But what of workers on more than one branch of entomology, or zoology? To keep card-catalogues—hence general indices— of their widely distributed interests would necessitate the employment of a clerk throughout the year.

I close with the classic from Pope, "He who knows how to prepare a good index, holds the eel of science by the tail."

VI. Standards for Titles.

In logical order the title should have been treated first. But since the title is usually the last thing written by an author for his contribution, so let its place be among the last in the order of standards.

Take any entomological journal in hand and glance over the titles of papers. Many of these will sound much like the following examples: "A Revision of the Genus Popocatepetl; Some New Species of Orizaba; A New Aconcagua; A New Variation and the Life History of Kilimanjaro alta; etc." Occasionally one meets a title like the following: "A New Genus and Species of the Family Sierra"; and indeed a rarity is "New Species of the Order Andes."

In North America alone there are about 70,000 described species of insects, distributed in approximately 8,000 genera (probably more). Nevertheless, everyone is, as a matter of course, expected to know immediately from the lucid "Genus Popocatepetl" just where the genus belongs, to what family, to which order. Everyone is expected to be familiar with all of the 8,000 genera and to have no difficulty at all in placing the genus revised or enlarged, as indicated by the title. And even considering that there are about 500,000 specific and 80,000 generic names in zoology, "Popocatepetl" is too important not to be as well known as "pater" and "mater."

Especially in taxonomic entomology the saying holds good: "Familiarity breeds contempt"—for others. Some taxonomists appear to become so obsessed with their particular specialty that other orders or families of insects do not exist for them. There are 18 other orders after Comstock, 30 others after Handlirsch (restricted to *Pterygogenea*—winged insects); yet these are of little importance beyond the fact that they exist and that some foolish people bother about them. So taxonomists of a certain type would have us believe. We are lucky, indeed, if with indignant compassion they will cite the family in which the order occurs; indignant, because "those barbarians" do not happen to take any special interest in their particular branch.

Let us go a step farther. There are eighty-two families in the order *Coleoptera*, sixty-one in *Diptera*, about seventy-five in *Lepidoptera*, about seventy in *Hymenoptera*, not to speak of *Hemiptera*, *Neuroptera*, *Pseudoneuroptera*, and other orders. A conservative estimate would show over four hundred families of insects in North America alone, distributed in nineteen (Comstock) or thirty-one (Handlirsch) orders. Most of these families average three to four subfamilies to each family, and two tribes to each subfamily. Figuring on this basis there are 1200 subfamilies and 2400 tribes of insects. And this for North American insects only! What of the orders, the families, the subfamilies, the tribes, the genera, of fishes, of mollusks, of birds, of mammals, of crustaceans, etc. in North America? What of their number in the entire world? Not all our articles are confined to a single fauna. The Central and South American faunas are beginning to be explored more thoroughly, as shown by the ever increasing number of articles upon the regions named.

And yet, on an average but six out of twenty titles cite the family, and but one of twenty the order. Of course, the fact that the journal is specially devoted to entomology, gives me a clue to the position of the genus; accordingly I know that the paper is an entomological paper, but that is all. But what of journals dealing with natural history in general? How can I know from the title whether the genus belongs to botany or to zoology or paleonotology, whether it is a paper on insects or canaries, on mollusks or angle-worms?

An hour spent in a scientific library in the classification of articles would be an educative influence for all those who neglect

the mention of family and order in their articles, The difficulties they would meet—such as antiquated catalogues, under-indexed catalogues, or, as in some cases, the entire lack of catalogues—would forever cure them of this apparently trifling but nevertheless momentous negligence. Even when there are good catalogues at hand, it is a complex proposition to place a genus. For the terminology of some orders, such as *Diptera*, and *Hymenoptera, Coleoptera and Hemiptera*, etc., is, in part, alike; the necessary consultation of both text and catalogue in such cases causes an irksome and avoidable loss of time.

The solution of all troubles is so simple, so obvious—in fact, it is inherent in the subject—that it seems strange why taxonomists have not adopted the simple means. But one entomologist is known to me who in all of his papers inserts the order name in his titles. That is the solution: Insert the order of the insect, bird, mammal, or whatever-it-be behind the genus and family name in the title. This holds good also for morphological, ethological and other papers as well as for those dealing solely with taxonomy.

VII. Standards for Reprints.

This chapter does not properly belong in this consideration. But since reprints form an important part of the specialists' literature, a few words on the topic may be of interest.

Sometimes I receive reprints of articles published by "Enigma" University; that is a tangible fact. The paging of the reprint is the same as originally published; that is another tangible fact. But I look in vain from page to page in the endeavor to discover the number or year of the volume, the month of publication, etc. That editor who arranged the reprint of an article sent me, published in nineteen-something on pages 260–290 of a certain periodical, yet paged the separate 1–30; and carefully effaced all reference to the name of the publication, the year or number of the volume, the year and month of publication;—that editor, I say, deserves no honorary mention. After guessing at the probable publications in which the article might have appeared, I looked over the recent volumes of many and ultimately succeeded in finding the exact place, page and time of publication. I owe that editor thanks, since through him I was led to other articles of high interest; but I spent an entire evening in trying to find out "What's which" in the reprint. To be fully consistent, the editor should have effaced the title of the article itself.

To be sure, this was an extreme case. Yet that in these "enlightened" days, after years of discussions, protests and recommendations, there should be men who retain the benighted idea that it is preferable to change the paging of reprints from the original—this seems hardly conceivable. Why the change at all? No advantage is gained thereby. On the contrary, it is a disadvantage for workers who are not constantly in touch with all the leading centers of scientific work and who have no large scientific library at their elbows. For these it results in tedious correspondence, and this most often when there is little time to be spared for these irksome labors.

One lucid individual went to another extreme. The travels of a certain explorer, together with the scientific results of his collections, as monographed by various specialists, were published in a large scientific journal. As all of these contributions were finally to be collected in a separate volume, and as the paging of this volume would be just as important for reference as that of the journal, the editor thought of a "happy" solution of all difficulties. Namely, the original paging of the contribution as it appeared in the journal was retained for the reprint; the future paging of the volume was also put in; and to meet all contingencies the reprint was given a special paging of 1—50 or other. Unfortunately, this genius forgot to note which was which, so that, as the printer's folio number and the publisher's file number are at the bottom of each page besides the three numbers above, I now have my choice between five numbers for page reference.

As a rule reprints do not suffer from surplus information as in the preceding case; they usually lack part of the necessary information. This lack in most cases is the absence of the volume number (or the year of the volume) from the reprint, or the year of publication, or both. Sometimes the two are given, but the name of the publication is nowhere indicated. The benign opinion that every scientific worker is familiar with the size of the volumes, the style of composition and the issues of "the four-hundred" leading scientific publications,—this opinion is, of course, founded on long experience and hence must be considered sound. If I receive a reprint that contains the year and number of the volume, but not the title of the publication itself, it is, therefore, a simple proposition to locate the correct journal from the size of the page and the style of com-

position, as there are only about three hundred others among the "four hundred" that resemble it.

Often the title of the journal is present and the number of the volume given, but not the year of the volume. The latter is omitted because it is a matter of common knowledge that the institution or society began its journal way back in the forties and that a new series is begun with each score of years; so that the tale, "Reprinted from the Enigmatical Journal, Series 4, Volume 17" will tell me all that is necessary to be told. From the number of the volume I ought to infer the year of the volume and if I am too much of an "ignoramus" as not to know such a monumental fact as the year a certain society or institution was founded,—well, then "look it up!"

Similarly, if I read 1906 on a reprint just received, I am to know intuitively that that means the year of the volume, not the year of publication; that the contribution had been in the hands of the editor since 1905, but owing to the press of legislative matters on the state printer could not be published until 1910.

It appears ridiculous that a matter intrinsically so simple, and extrinsically of such vital importance as the correct marking of reprints should be so carelessly treated. Or is there really a living editor who would consider the puny additional (?) expense of the line on the reprint giving all the needed information? Penny wise, pound foolish. Can a simpler solution be found than "Reprinted from the Ecstatic Journal, Series 6, Volúme 14, pages 28–67, 1910 (Publ. May, 1910)"?

Conclusion.

The scope of matters that are left to our imagination, divinition and intuition by scientific papers is monumental. A catalogue of merchandise that does not describe the ware and state its prices would be flung aside instantly. Yet for science anything, no matter how poorly constructed, how poorly presented, should be acceptable. Science should lead the world. But if science in general cannot apply more logic to its methods than taxonomists apply to taxonomy, its leadership will be short-lived. This may be a harsh and pessimistic view; but I believe that I do not stand alone in this attitude.

Again referring to the merchandise simile—imagine to yourself a catalogue of merchandise, say furniture, that would not bear the proper legend on the cover; further, that the pages

contained nothing else but names of furniture—no illustrations of the same, no measurements, no prices quoted;—imagine the action of the man receiving it! Certainly no other place than the paper-basket would be accorded it. And certainly many of the articles of our journals are little better as far as usable information is concerned than the furniture catalogue just referred to. Is it with reverence that we remember such names as Smith and Walker of British Museum fame? And yet some systematists appear to have chosen them as patrons and models for imitation. They succeed only too well in imitating them, and occasionally outdistance them.

One may say, these are all minor matters. That is true. But their aggregate forms an imposing array. One drop in a cup will not make it acrid; but a number of drops will change it into a cup of bitterness. So with entomology. One little carelessness does not amount to much; but many will fill even the most ardent student with feeling akin to disgust.

Science is no longer in its infancy and we have a right to demand advanced methods of work. The desire for improvement is innate to all men. I have never heard of a writer (at least in science) who was well satisfied with what he had written. Literary critics say, "An author is his favorite reader"; but self-satisfaction is short-lived, more so in science than elsewhere. Hence the attitude of scientific workers toward their work may be defined as "a minimum of self-conceit with a maximum of scruples." Writers do not confess these qualms of the intellectual conscience to the public, but reserve them for some private interchange of confidences. Unfortunately, the ratio of these qualms decreases, not inversely, but in the same ratio that the system and methodical effort of the worker decreases; so that the most conscientious workers are usually most diffident as regards their own work (all the more, as those contributions requiring the greatest amount of labor and time generally show the least for it), while the careless workers have few misgivings of their efforts. I have an inkling that some day to come a contribution will have to be passed upon by a commission of scientists (like so many examination papers) before they are declared acceptable to science.

Cooperation and centralization (to a certain extent) are desirable. There ought, in fact, to be a scientific clearing house somewhere in this beautiful world, and I hope that it will be achieved some day.